United States
Department of
Agriculture

Forest Service

Forest Pest
Management

Davis, CA

FORTH REPORT

NATIONAL STEERING COMMITTEE FOR MANAGEMENT OF GYPSY MOTH AND EASTERN DEFOLIATORS

Healthy Forests
Make A World
Of Difference

FPM 92-2
NOVEMBER 15, 1991

Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

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FORTH REPORT

NATIONAL STEERING COMMITTEE FOR MANAGEMENT OF GYPSY MOTH AND EASTERN DEFOLIATORS

Prepared by:

John W. Barry
Chairperson

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Forest Pest Management
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CONTENTS

I. INTRODUCTION

The fourth meeting of the National Steering Committee for Management of Gypsy Moth and Eastern Defoliators met at Blacksburg, Virginia, September 10-11, 1991. The primary purpose of the meeting was to identify national needs for managing eastern defoliators and to report these needs to the Director, Forest Pest Management, USDA Forest Service, Washington, DC.

A. Attendees

J. Robert Bridges	WO/FIDR (Washington, DC)
Bill Buzzard	PA Bureau of Forestry (Middletown, PA)
Leo Cadogen	FPMI (Sault Ste. Marie, Ontario)
Tony Chiotakis	North Carolina Department of Agriculture (Raleigh, NC)
Harold Flake	R-8/FPM (Atlanta, GA)
Tom Hofacker	WO/FPM (Washington, DC)
Win McLane	USDA/APHIS (Otis AFB, MA)
Mike McManus	NE/FIDR (Hamden, CT)
Steve Munson	R-4/FPM (Ogden, UT)
Dick Reardon	NA/FPM/AIPM (Morgantown, WV)
Jeff Witcosky	R-8/FPM (Harrisonburg, VA)
Harry O. Yates III	SE/FIDR (Athens, GA)
Jack Barry (Chairperson)	WO/FPM (Davis, CA)

William Buzzard, Pennsylvania, substituted for Barry Towers. Addresses and telephone numbers of committee members are provided in Appendix A.

B. Committee Purpose

The purpose of this committee is to identify national needs for managing gypsy moth and defoliators of eastern forests. Management, within the context of the committee, includes direct control with biological and chemical insecticides, cultural control, population monitoring, survey methodology, and risk/hazard rating. The

committee identified needs and ranked them in order of priority by vote of its members. A separate category of recommendations that covers administrative issues is included in this report.

The majority of needs identified by this committee are candidates for WO/FPM technology development funding. NA/AIPM and other sources of funding should also be pursued to address needs identified by this committee. The call letter for technology development proposals was sent to FPM field offices by Director, Forest Pest Management on September 16, 1991 with responding proposals due by November 15, 1991.

With the expanded scope of the committee, sub-committees will be needed to further evaluate selected issues and develop recommendations. Three sub-committees, listed in paragraph II, C were appointed at the Blacksburg meeting. Sub-committee member participation is subject to concurrence of individuals and that of their supervisors. A letter of instruction that delineates its charge and product delivery schedule will be sent by the Chairperson to each sub-committee.

C. Reports to the Committee

Committee members listed below submitted written reports that are enclosed in the Appendix:

Bill Buzzard
Leo Cadogen
Tony Chiotakis
Win McLane
Steve Munson
Dick Reardon
Harry Yates

II. NATIONAL NEEDS/CURRENT ACTIONS

A. National Needs

These are listed in order of priority with number one being highest priority. Sub-units within the numerically numbered priorities share equal priority.

1. Evaluate current spray aircraft guidance including global position system (GPS) and recommend for operational and/or field evaluation.

2. a. Evaluate, modify, and/or develop application equipment for gypsy moth pheromones.

   b. Develop methods for mass balance or total accountancy of pesticides applied by aerial and ground equipment.

committee identified needs and ranked them in order of priority by vote of its members. A separate category of recommendations that covers administrative issues is included in this report.

The majority of needs identified by this committee are candidates for WO/FPM technology development funding. NA 4111 and other sources of funding should also be pursued to address needs identified by the committee. The call letter for technology development proposals was sent to FPM field offices by Director, Forest Pest Management on September 16, 1991 with responding proposals due by November 15, 1991.

With the expanded scope of the committee, subcommittees will be needed to further evaluate selected issues and develop recommendations. Three subcommittees listed in paragraph [illegible] were appointed at the Pittsburgh meeting. Subcommittee participation is subject to concurrence of [illegible] and their supervisors. A letter of instruction that delineates charge and product deadlines schedule will be sent by the chairperson to each subcommittee.

C. Reports to the Committee

Committee members listed below submitted written reports that are enclosed in the Appendix:

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

II. NATIONAL NEEDS/CURRENT ACTIONS

A. National Needs

[illegible] order of priority with number one being highest [illegible] within the numbered [illegible] priorities [illegible]

1. Evaluate current [illegible] guidance [illegible] position [illegible] recommend for [illegible] and/or field evaluation.

2. [illegible] and/or develop [illegible]

[illegible]

3. a. Improve methodology for monitoring, detecting (low and high populations) of gypsy moth and predicting gypsy moth populations.

   b. Identify and/or evaluate weather stations to support field tests and operational control projects.

   c. Determine the lower thresholds of Bacillus thuringiensis for fixed BIU rates when varying the volume by diluting with blank formulation.

   d. Study efficacy, of virus and B.t. sprays relative to drop size, volume, and concentration.

4. Evaluate GPS for positioning, locating, and retrieving pheromone traps and other FPM geographical positioning needs.

5. Determine elevational limits of gypsy moth in the West.

6. Validate gypsy moth phenology model in the West and East.

7. a. Evaluate the CASPR aircraft productivity model on an operational project in the East.

   b. Identify another insecticide to replace DDVP for use in the milk carton trap.

   c. Develop a safe and rapid method of calibrating spray aircraft with engines not running.

B. **Current Actions**

The committee established the three sub-committees listed below. Jack Barry will coordinate member participation with their respective supervisors.

1. Pilot Training

Chairperson - Bob Adams, FS

Members - Win McLane, APHIS
Craig Howard, FPMI/Canada
Tim Roland, APHIS
Bill Buzzard, State of Pennsylvania

Purpose - Determine if need to train forest spray pilots is real or perceived. If real, sub-committee shall submit recommendations to the committee at its next meeting.

2. <u>Non-target Impact</u>

Chairperson - Dick Reardon, FS

Members - Leo Cadogen, FPM/Canada
Steve Munson, FS

Purpose - To identify what is known and what is needed but not known on impact of B.t. and Dimilin on non-target lepidoptera, aquatics, birds, and small mammals. Prepare a bibliography and recommendations, and submit these to the committee by the next meeting in 1992.

3. <u>Canopy Characterization</u>

Chairperson - Jack Barry, FS

Members - Harold Flake, FS
Dave Miller, Univ. of Connecticut
Bruce Grim, U.S. Army
Jim Rafferty, U.S. Army
Milt Teske, CDI

Purpose - To coordinate needs and develop plan to acquire data and information on description and quantification of forest canopies for FSCBG model inputs. Report to committee by next meeting in 1992.

III. 1990 RECOMMENDATIONS AND OTHER CONTINUING NEEDS

A. Laboratory and/or Investigations

1. Work continues by Dave Miller at University of Connecticut on describing canopy architecture and comparing FSCBG predictions.

2. Pat Shea reported that ELISA technique is not feasible for rapid on-site determination of B.t. tank-mix potency. Gary Daterman will pursue the Lloyd Browne technique that might be an acceptable assay technique.

3. Wind tunnel tests of selected Foray 48B, B.t. tank-mixes have been sponsored by Temple Bowen (NOVO) and data available from Temple.

4. No report from NA on pine sawfly and pear thrip.

5. Win McLane reported that there were no complaints in 1991 of automobiles paint damage by spraying.

B. **Field Tests**

1. Testing of lower doses/volumes of Dimilin and anti-evaporants is continuing. Dimilin 4L was tested in the East in 1991.

2. FSCBG canopy penetration prediction studies continuing in the East and West during 1991. Paper published September 1991 in Journal of Applied Meteorology by Teske, et al. on FSCBG comparing predictions in a seed orchard.

3. APHIS is doing a study on deposition and drift from hydraulic sprayers.

C. **Demonstrations**

Steve Munson has conducted tests and is evaluating data of the gypsy moth phenology model project.

D. **Equipment, Models, and Technology Development**

1. Need continues to evaluate portable weather stations for support of operational projects.

2. Field studies conducted by Bruce Grim and Jim Rafferty on penetration of B.t. into an oak canopy. Data are being analyzed.

3. No project has been initiated by FPM to address the spray block marking and the spray aircraft guidance needs. Proposals have been drafted by MTDC and funding decisions will be made in FY 92.

4. Airport tests were conducted by the Forest Service in September 1991 of DC-3 spray deposition to compare to AGDISP predictions to result from Kromekote cards. NA will analyze data and prepare report.

E. **Administrative**

1. Win McLane, Mike McManus, and Dick Reardon will review and revise tank-mix recommendations for 1992.

2. Workshop was held by NA & R-8 on developing guidelines for aircraft contracting.

3. Jesus Cota is USDA-FS's contact with EPA.

4. Jim Space is on the USDA/EPA Coordinating Committee. The 10 acre rule for experimental use permits might be lifted by EPA for pheromones. Industry has its own pheromone registration group.

5. Some progress, although not well defined, has been made on monitoring gypsy moth populations. Tests are being conducted in

the East and West. Jessie Logan at VPI is working on phenology model through a cooperative agreement.

F. **Other Continuing Needs**

1. Develop method of accounting for all spray (total accountancy) that is applied by either aerial or ground application.

2. Determine need and alternatives for a carrier to be used with TM-Biocontrol and Gypchek.

3. Need to press forward to obtain quantitative data on spray deposit and drift, and buffer zones for ground spray operations.

4. Pursue spray block marking and aircraft guidance as needs continue and should be addressed.

5. Need continues for the gypsy moth phenology model, methods for monitoring and determining timing of control operations. Need to test model in the West.

6. Need gypsy moth low population eradication strategy for the West and continued research on the application of F1 sterile technique.

7. Need continues for understanding relationship of drop size and spray volume to efficacy.

8. Need standard spray deposit card spread factors and methodology.

9. Need continues to evaluate stickers and UV screens for tank-mixes.

10. Need to develop formulations and delivery system for pheromones.

11. Need to evaluate Airbi atomizer in wind tunnel to characterize atomization and conduct airport trials.

12. Need to evaluate computer model CASPER on an operational project in the East.

13. Determine survival of gypsy moth at elevations above 8,000 feet in the West.

14. Need to test traps/pheromone for efficacy for the Asian Gypsy Moth (AGM). Relationship between trap catches of males and pressure of females?

15. Develop ability to distinguish males of AGM from the European strain of gypsy moth.

16. Develop parameters for regulatory, survey, and control actions for AGM.

17. Develop additional basic information on biology, ecology, behavior, and control of AGM in siberia, on ships and expected in the United States. Data on eclosion/developmental times and temperature are of particular concern in order to determine which times of year AGM can be successfully established outside Siberia.

18. Need to review the APHIS Survey Plan and establish realistic protocols supported by the survey plan to detect isolated infestations before they reach an upper size limit. Current plan is inadequate as written, particularly for remote/rural areas in the West.

19. Develop information on larval (1st instar) and adult dispersal in isolated infestations (particularly in mountainous terrain), to keep eradicative spray blocks as small as possible.

20. Review natural spread and vegetation patterns. Make long-term probability predictions on natural spread.

21. Develop method of linking trapped males with egg masses/pupal cases in low density populations commonly found in the West.

22. What native natural enemies of gypsy moth (known or potential) exists in the West, and what influence do they have on introduced gypsy moth populations.

23. What is (or will be) the impact of introduced gypsy moth populations on riparian ecosystems in the West.

24. What native western lepidopterans and other non-target insects are threatened by applications of B.t., carbaryl, dimilin, etc. in both native and urban forests of the West.

25. What is the prognosis for using baculoviruses as control strategies in the West. Continued research to improve the consistency of NPV results in low density populations of GM.

26. Need better trapping design to detect and delimit GP populations in mountainous terrain, where tremendous variations in drainage wind patterns influence male moth dispersal.

27. Develop survey methods to detect egg masses, pupal cases, female moths in mountainous terrain.

IV. SUMMARY

The **National Steering Committee for Management of Gypsy Moth and Eastern Defoliators** met at Blacksburg, Virginia, September 10-11, 1991. The purpose of the meeting was to identify national needs for managing eastern defoliators and to report these needs to the Director, Forest Pest Management. Needs were identified, listed by priority, and submitted to WO for funding considerations on September 17, 1991. Other recommendations are provided in this report for management consideration. Three sub-committees were appointed with the charge to develop plans and recommendations related to managing gypsy moth and other eastern defoliators. The next meeting of the committee, hosted by the Southwest Region, is tentatively scheduled to be held at Las Cruces, New Mexico, August 17-19, 1992.

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APPENDIX
COMMITTEE MEMBER AND STATE REPORTS

1. John Anhold, Steve Munson, and Mark Quilter
2. Bill Buzzard
3. Leo Cadogen
4. Tony Chiotakis
5. Harold Flake
6. Win McLane
7. Dick Reardon
8. Harry Yates
9. State Reports

Appendix

1991 UTAH GYPSY MOTH ERADICATION PROGRAM

JOHN ANHOLD & STEVE MUNSON
USDA FOREST SERVICE / R-4 FOREST PEST MANAGEMENT

1991 was the third year of aerial application to eradicate gypsy moth populations in Northern Utah (Figure 1). Since 1990, no egg masses or life stages other than the male moth have been found in any of the infested areas. All 1991 block boundaries were based on male moths captured during the 1991 flight period. Multiple catches and/or clusters of traps with single catches were placed within 1991 treatment boundaries. Isolated single catches were often not included within the spray block areas.

TRAPPING

Gypsy moth trapping in Utah consists of four types of trapping arrays to meet survey and eradication objectives, these are; detection, delimitation, mass and move-in trapping schemes (Table 1). Although the total number of pheromone traps deployed has increased substantially over the last four years, male moths catches have steadily declined since the 1989 application program (Figure 2 & 3). The following is a summary of trap results for each:

Detection Trapping: The detection survey uses guidelines established by the Animal, Plant, Health Inspection Service (APHIS), where all potential gypsy moth habitats are surveyed at least once every four years. The detection program was administered by APHIS personnel who deployed 778 traps statewide. Trapping results revealed only one male moth caught in Alpine, Utah. This single male catch is between two current infestations in Provo and Salt Lake City, Utah. In 1992, delimiting traps will be placed around the positive catch site to increase trapping efficiency.

Delimitation Trapping: Approximately 5,400 traps were placed in the delimitation survey within and surrounding the 1991 spray blocks. Of these, 2,500 traps were deployed in mountainous terrain. Only 4 percent of the 5,400 traps were listed as missing in the 1991 delimitation survey. In 1991, 191 moths were caught in the delimitation survey and 163 of these were catches outside of the treatment areas. Most of these catches were in areas where no traps had been placed previously. Within the 1991 treatment blocks only 28 moths were caught compared to 514 caught in the 1990 survey of the 91 treatment areas (Table 2). Portions of the 1990 treatment blocks were retreated in 1991. Within these areas moth catches declined from 241 in 1990 to 63 in 1991 (Table 3).

Move-In Trapping: APHIS initiated a move-in trapping program in 1991. As residents applied for Utah driver's licenses, individuals who moved from generally infested areas were targeted to receive a telephone questionaire. From the information supplied by the new Utah resident, APHIS personnel would decide if a trap should be placed at the residential site. Of the 180 traps placed in this survey, no male moths were caught.

Mass Trapping: Mass trapping was conducted within residential areas of each block using 1,844 traps on a nine trap per acre grid. Costs associated with this type of trapping array were $5.00 per trap (placement and retrieval).

TREATMENT

Aerial application of Bacillus thuringensis, (Bt) was applied over 14 blocks consisting of 29,925 acres within a five county area in 1991 (Table 4). Each spray block was treated three times at five day intervals. One Hughes 500 and two Bell 206 B3's were used to apply the biological insecticide. All aircraft were equipped with four electronic rotary atomizer Beecomist nozzles calibrated to deliver 64 oz. per acre. Foray 48B at 24 BIU's was applied neet for all applications. Application costs, which include the cost of the Bt and aerial application, was $8.80 per acre. Total project costs were approximately $1.7 million, based on 89,775 acres treated (3 X 29,925 acres), total per acre costs were $18.94.

Male moth populations were reduced 95 percent within the treatment blocks. Because of male moths captured in some areas of the 1991 blocks, 3,197 acres (11 percent of the 1991 treatment acreage) will require retreatment in 1992. The proposed spray acreage for 1992 is comprised of seven blocks totalling 16,154 acres (Table 5). Of this amount, 9,558 acres are on federal land and 6,595 acres are on state and private lands.

Annual surveys for sensitive species of non-target moths and butterflies are conducted so mitigating measures may be taken if there are conflicts between treatment and sensitive species. In treatment areas where conflicts occur, steps are taken to exclude the area within the treatment block from aerial applications of Bt. Most of these exclusion sites are areas where no host vegetation exists for the gypsy moth. Where susceptible host vegetation exists, ground treatments and mass trapping are used to suppress gypsy moth populations.

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Table 1. Trap Arrays and Number Placed in Utah from 1988-1992.

Trap Type	1988	1989	1990	1991	1992
Urban Delimiting	1550	3100	3100	2330	2000
Mountain Delimiting	237	1228	1990	2492	2750
Detection	-	570	169	800	800
Mass	-	500	2210	2014	500
Move-In	-	-	-	180	250
TOTAL	1737	5398	7469	7818	6300

Table 2. Total Male Moths Trapped Per Treatment Block. 1990 - 1991

Spray Block Area	1990	1991	Percent
DA1 - Parrish Creek	26	2	92
DA2 - Mueller Park	41	3	93
SL1 - Red Butte	7	0	100
SL2 - Burr Fork	4	0	100
SL3 - Alexander Creek	20	1	95
SL4 - Mt. Dell	8	0	100
SL5 - Millcreek	279	20	93
SL6 - Heughs Canyon	6	0	100
SL7 - Knudsens Corner	20	0	100
SL8 - Deaf Smith	46	1	98
SU1 - Big Bear Hollow	3	0	100
UT1 - Vivian Park	24	1	96
UT2 - Hope C-ground	24	0	100
UT3 - Squaw Peak	6	0	100
Total	514	28	95

Table 3. Total Male Moths Trapped Within 1990 Treatment Blocks. 1989 - 1991

Spray Block Area	1989	1990	1991
SL1 - Millcreek	490	199	36
SL2 - Mt. Aire	6	0	1
SL3 - Lambs Canyon	9	0	4
SL4 - Hatch Canyon	10	0	0
SL5 - Little Mtn.	5	0	0
SL6 - Tolcat	9	3	0
SL7 - Lower Big Ctn.	7	0	0
SL8 - Upper Big Ctn.	6	0	0
SL9 - Top of the World	66	12	0
SL10 - Little Ctn.	20	3	0
SL11 - Bells Canyon	7	0	11
DA1 - Bountiful	703	15	6
UT1 - Provo	901	9	5
Total	2,239	241-89%	63-97%

Table 4. 1991 Spray Block Acreage

Block #	Non-Federal	Federal		Total Federal	Total Block
		Forest	Wilderness		
DA1	539	2950	0	2950	3489
DA2	1851	2842	0	2842	4693
SL1	217	989	0	989	1206
SL2	166	6	0	6	172
SL3	1640	440	0	440	2080
SL4	362	63	0	63	425
SL5	1788	1523	2677	4200	5988
SL6	233	14	375	389	622
SL7	72	0	0	0	72
SL8	806	572	741	1313	2119
SU1	507	0	0	0	507
UT1	2860	2479	0	2479	5339
UT2	1107	1205	0	1205	2312
UT3	90	811	0	811	901
TOTAL	12238	13894	3793	17687	29925

Table 5. 1992 Spray Block Acreage

Block #	Block Name	Acres
SL1	Mill Creek	8,829
SL2	Parleys Canyon	1,079
SL3	Bells Canyon	1,335
UT1	North Fork	1,432
UT2	Provo	301
WA1	Sunday Canyon	1,915
DA1	Ward Canyon	1,263
Total		16,154

Report on Utah Gypsy Moth
1988 - 1992

Mark Quilter
Steve Munson

Figure 1. History of Gypsy Moth Treatments in Utah.

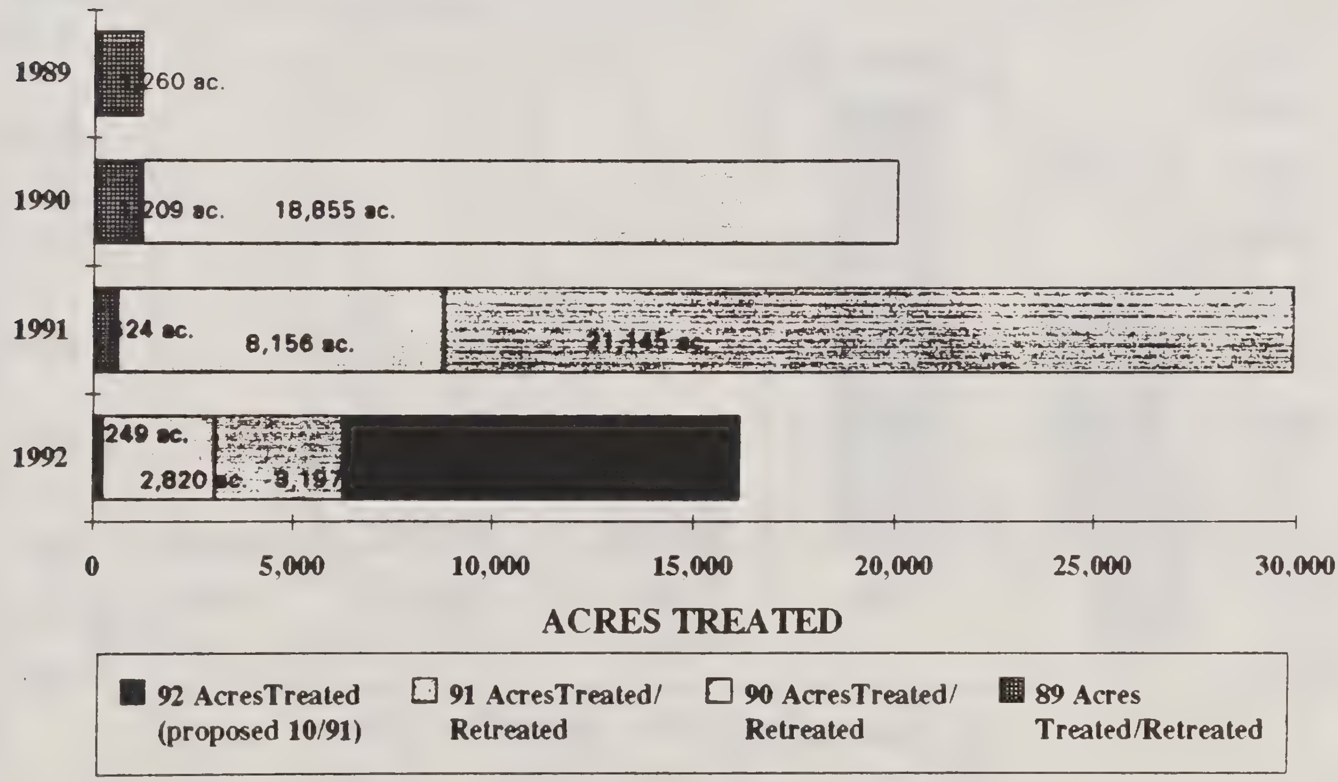


Figure 2. Gypsy Moth Male Moth Catches from 1988 - 1991.

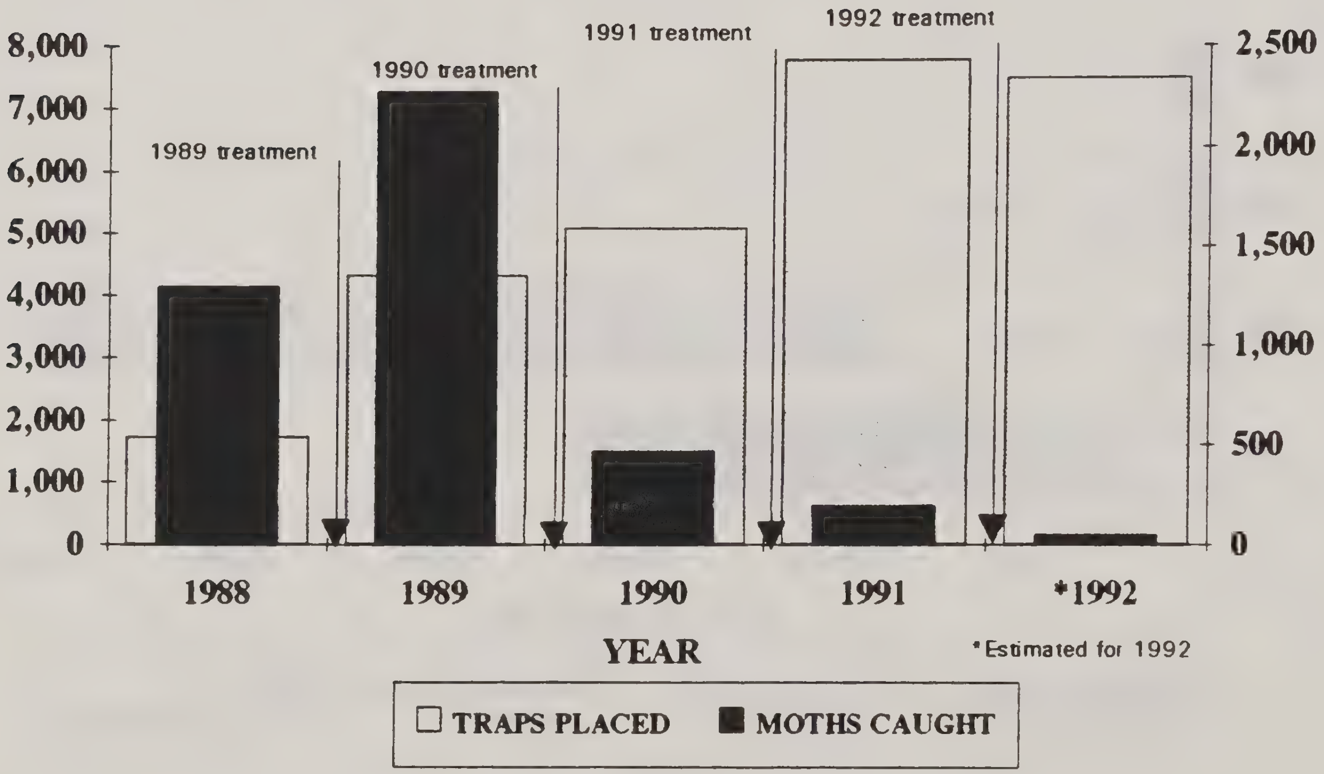
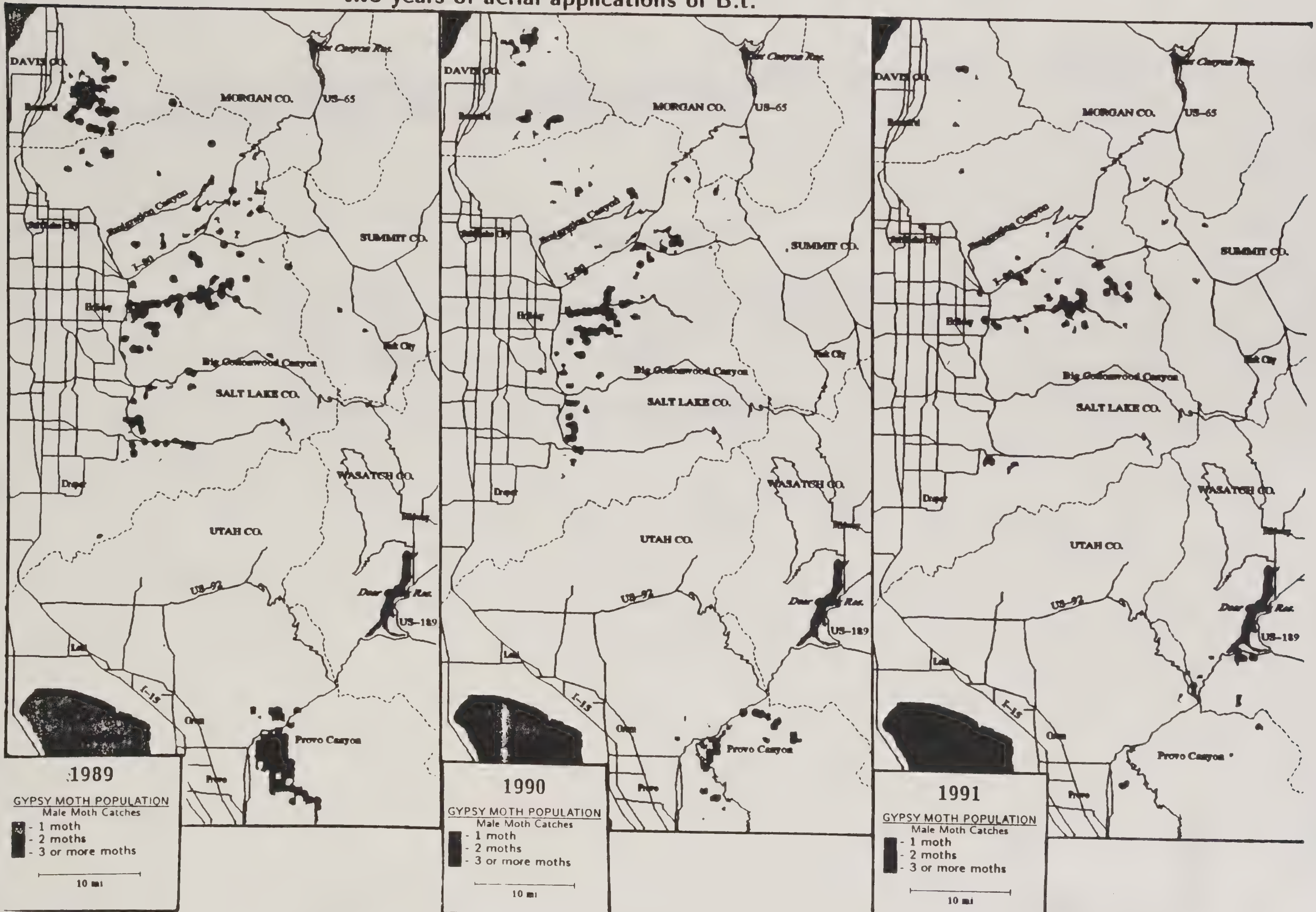


Figure 3. Area effect of successful Gypsy Moth catches. Note significant reductions in Provo Canyon and Bountiful following two years of aerial applications of B.t.



Steve Munson
September 1991

CANOPY PENETRATION OF GAMBEL'S OAK BY AERIAL APPLICATION OF BACILLUS THURINGIENSIS ALONG THE WASATCH FRONT (1990-1991)

TEST COOPERATORS

* USDA FOREST SERVICE FOREST PEST MANAGEMENT, DAVIS, CA.
* USDA FOREST SERVICE R-4, OGDEN, UT.
* US ARMY DUGWAY PROVING GROUND, DUGWAY, UT.

Steve Munson

OBJECTIVES

* MEASURE THE PENETRATION OF LIQUID BACILLUS THURINGIENSIS INTO GAMBEL'S OAK CANOPY WHEN AERIALLY DISSEMINATED FROM A HELICOPTER. (1990-1991)

* EVALUATE CAPABILITY OF FSCBG MODEL TO PREDICT CANOPY PENETRATION BASED ON ESTIMATES OF THE STAND DENSITY AND FOLIAGE EMERGENCE FROM ON-SITE MEASUREMENTS AND PHOTOGRAPHIC PROCEDURES. (1990)

* EVALUATE THE USEFULNESS OF THE LAI-2000 PLANT CANOPY ANALYZER IN OBTAINING THE NECESSARY VEGETATION PARAMETERS FOR INPUT TO FSCBG. (1991)

PROCEDURES

* TEST GRID SITES: PARLEY'S CANYON(1990-91), MT OLYMPUS(1990), AND OREM(1990)
* KROMEKOTE CARD SAMPLING EVERY 2.5 M ALONG 100 M LINE AT EACH SITE
* 20 VERTICAL SAMPLING POLES REACHING ABOVE CANOPY (FIGURE1)
* PHOTOGRAPHIC RECORD OF LEAF EMERGENCE (1990) (FIGURE 2)
* LAI-2000 MEASUREMENTS OF LEAF EMERGENCE (1991) (FIGURE 3)
* METEOROLOGICAL SUPPORT: TEMP, RH, WINDS (1990-91) (FIGURE 4)

RESULTS

* OBJECTIVE 1 WAS SATISFIED AND THE 1990 RESULTS ARE SUMMARIZED IN FIGURES 5-13. 1991 CARDS ARE CURRENTLY BEING ANALYZED.

* OBJECTIVES 2 AND 3 REMAIN TO BE ANALYZED.

* THE LAI-2000 PLANT CANOPY ANALYZER OFFERS THE MEANS TO DIRECTLY MEASURE SOME OF THE INPUT QUANTITIES NECESSARY FOR THE CANOPY PENETRATION PORTION OF FSCBG. THIS INSTRUMENT WAS UTILIZED FOR THE 1991 TEST AND WILL LIKELY LEAD TO MODIFICATION OF THE CANOPY PENETRATION MODEL. COMPLETE RESULTS OF THE 1991 TEST ARE NOT AVAILABLE AT THIS TIME; HOWEVER, THE FRACTIONAL PENETRATION RESULTS FROM THE LAI-2000 ARE SHOWN IN FIGURE 14.

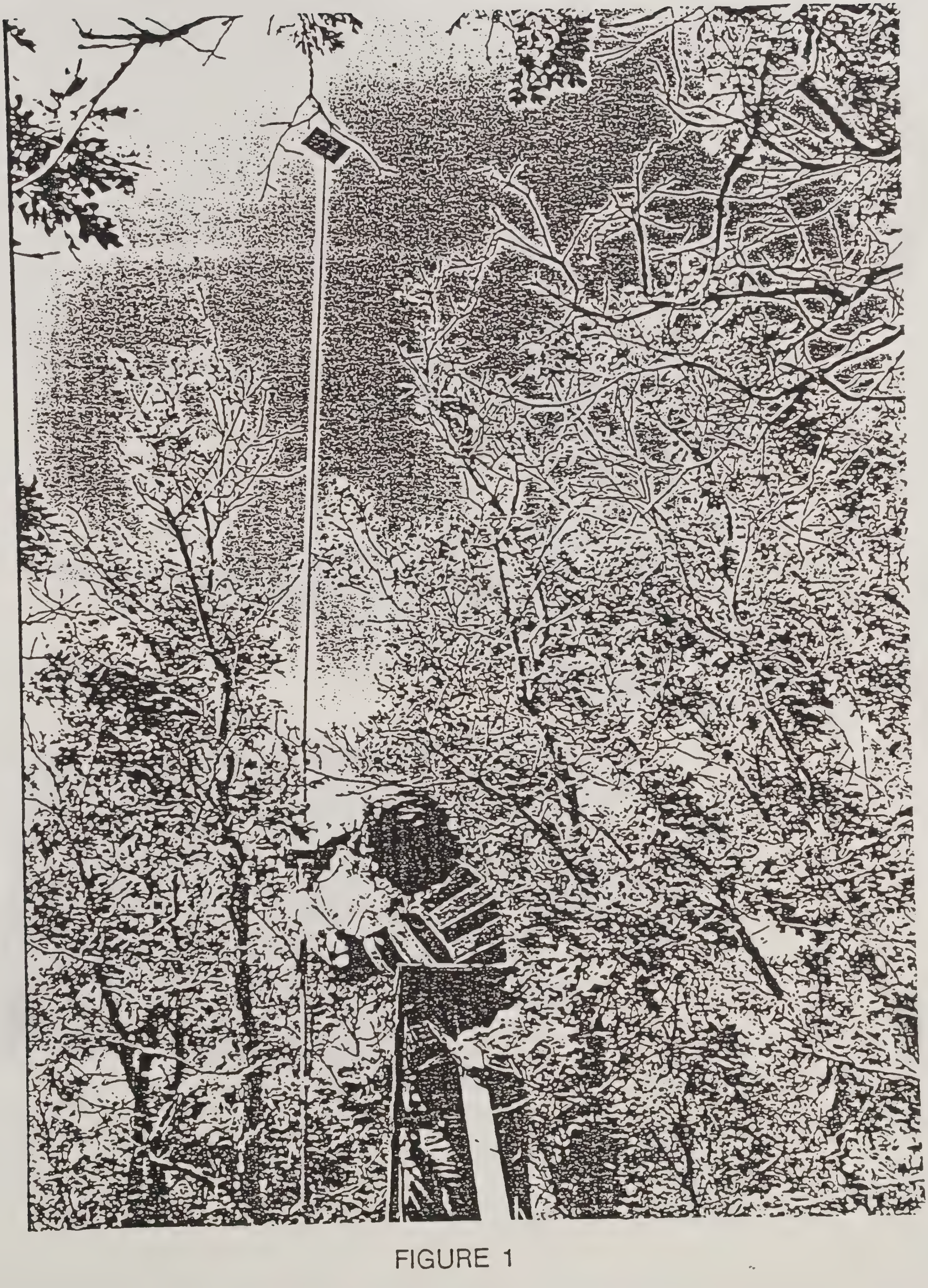


FIGURE 1

LEAF EMERGENCE AND TYPICAL TREE PROFILE FOR PARLEY'S CANYON TRIAL 1990

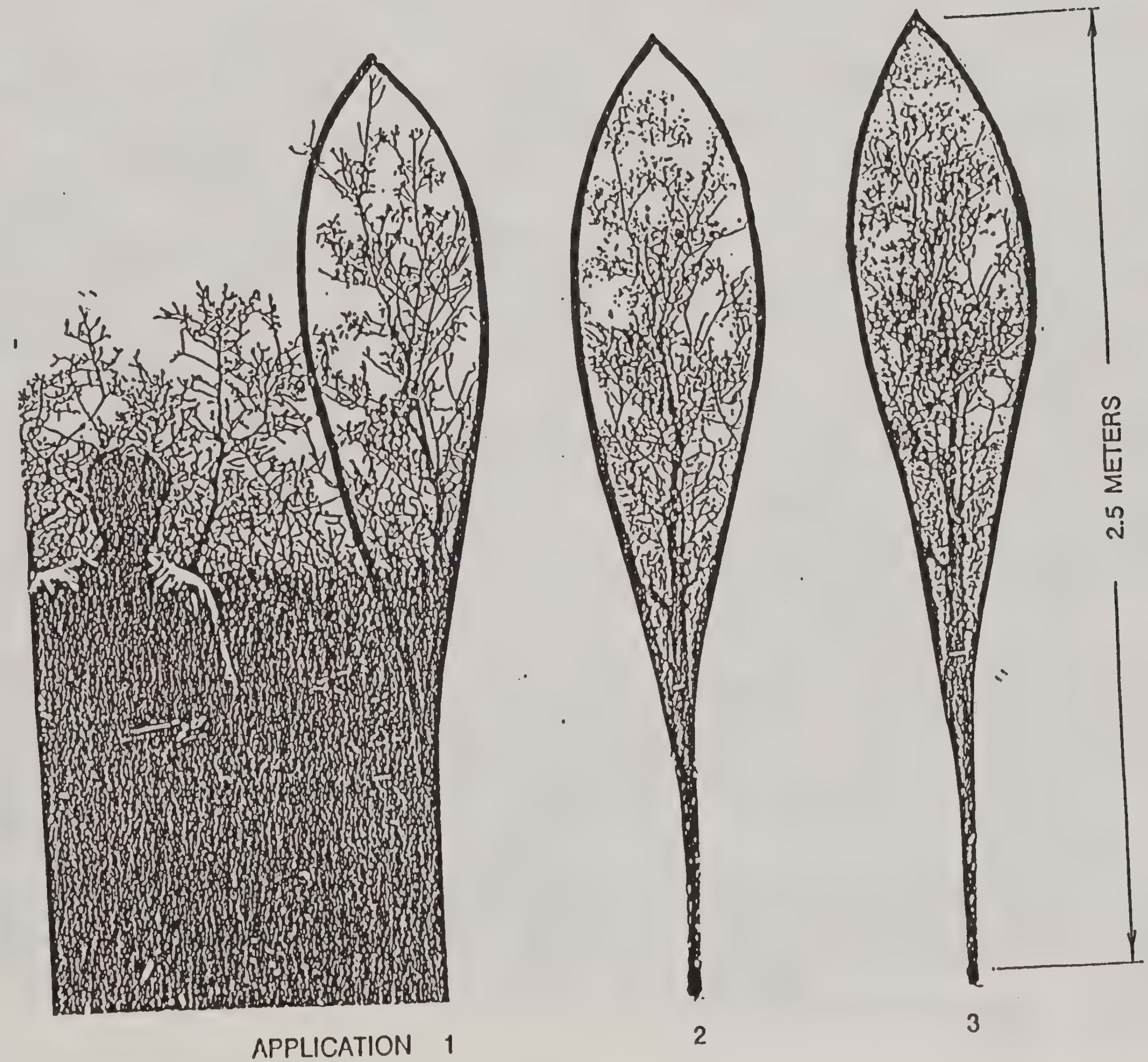
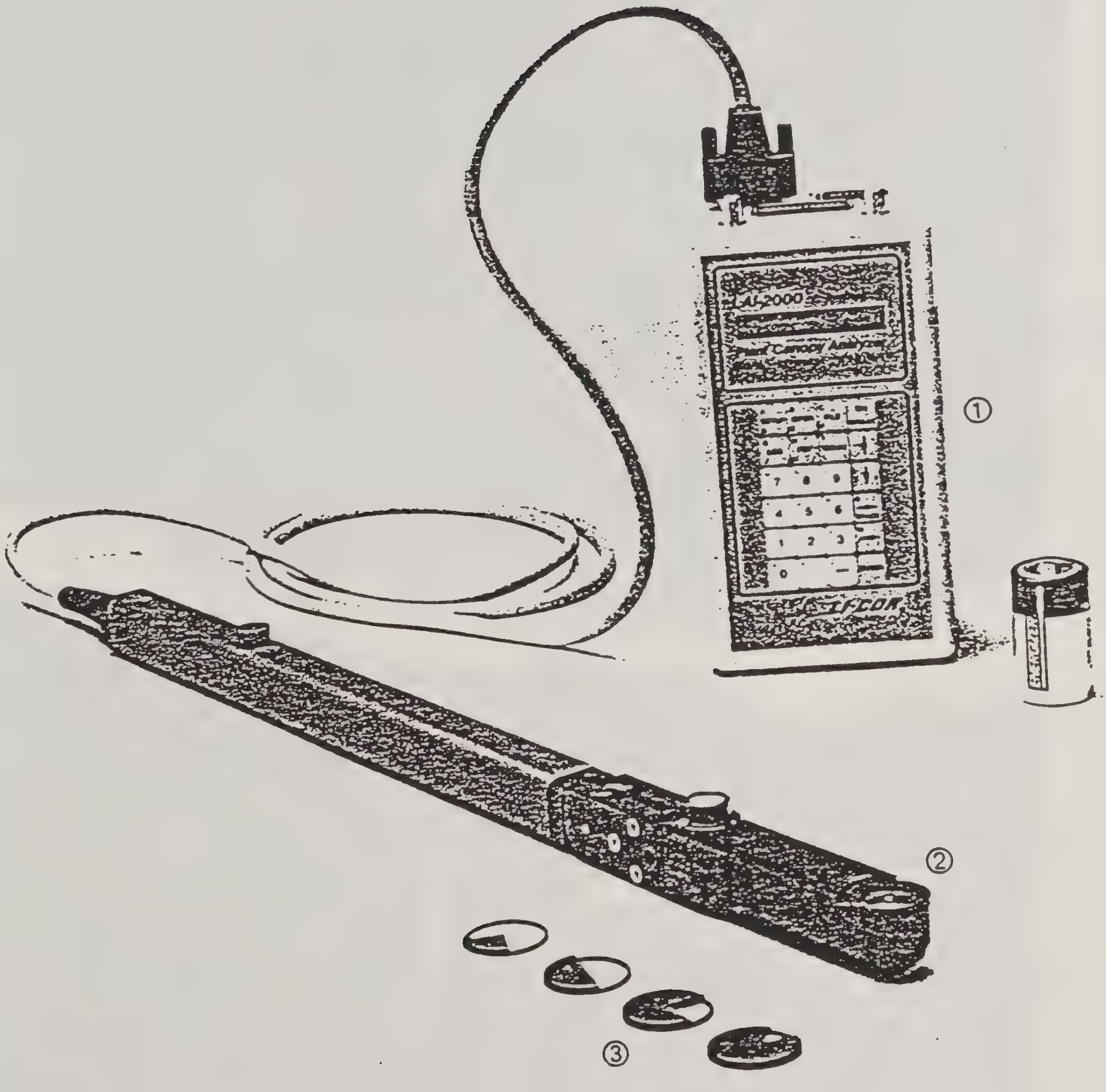


FIGURE 2



The LAI-2000 Plant Canopy Analyzer includes 1) The LAI-2070 Control Unit; 2) LAI-2050 Optical Sensor; 3) View Caps for the LAI-2050.

FIGURE 3

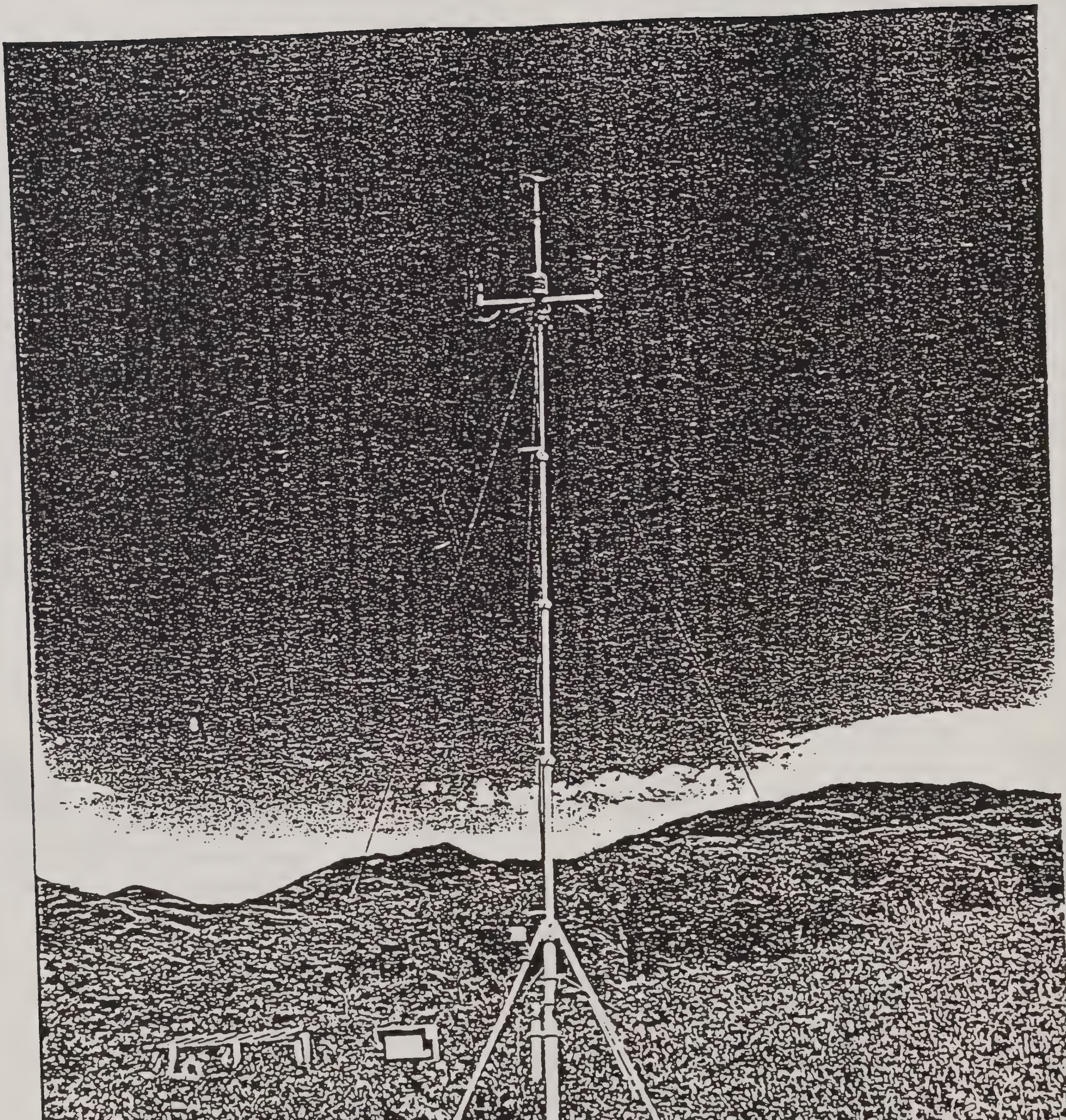


FIGURE 4

UTAH GYPSY MOTH 1990

Lamb's Canyon Application #1

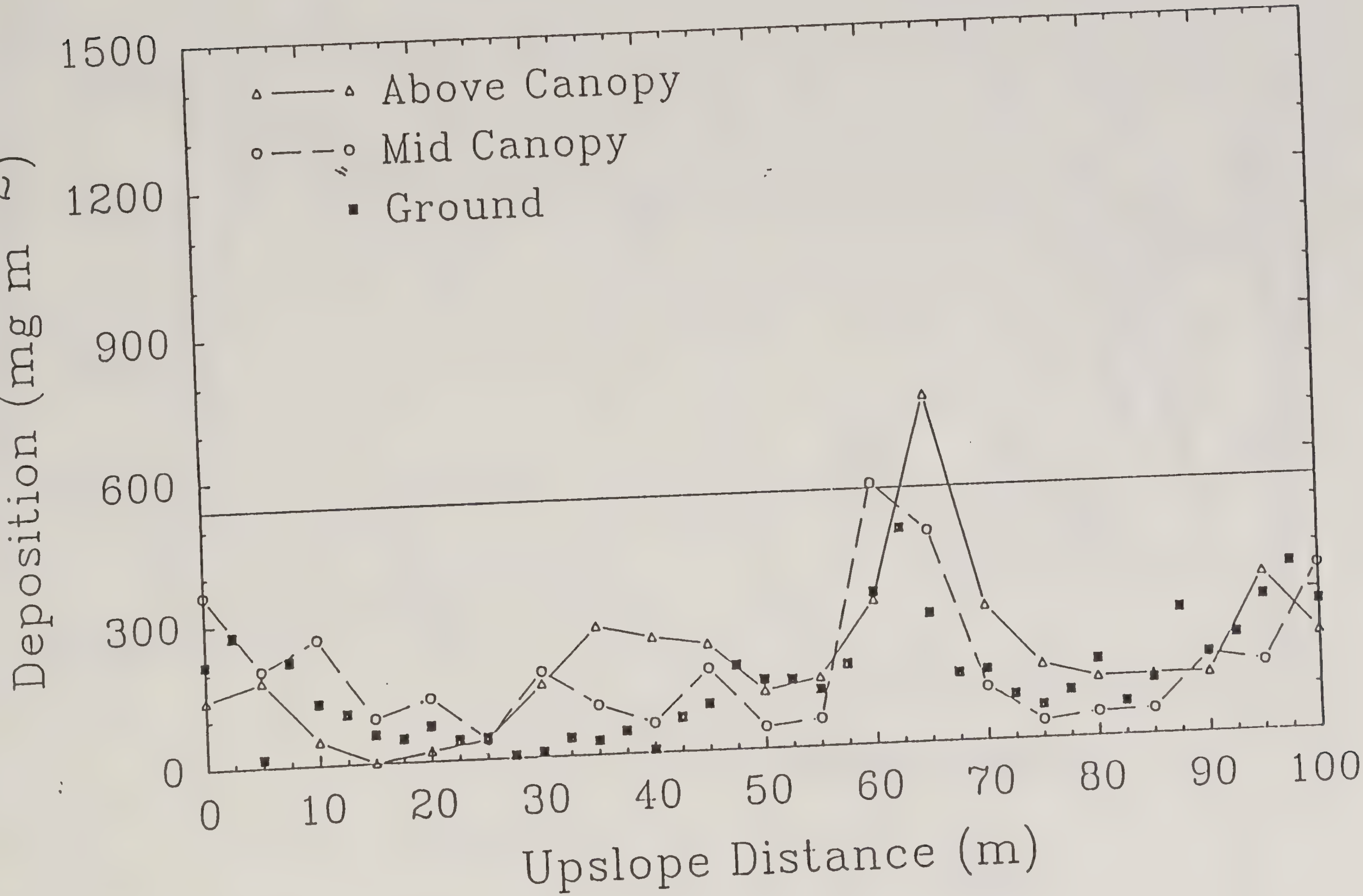
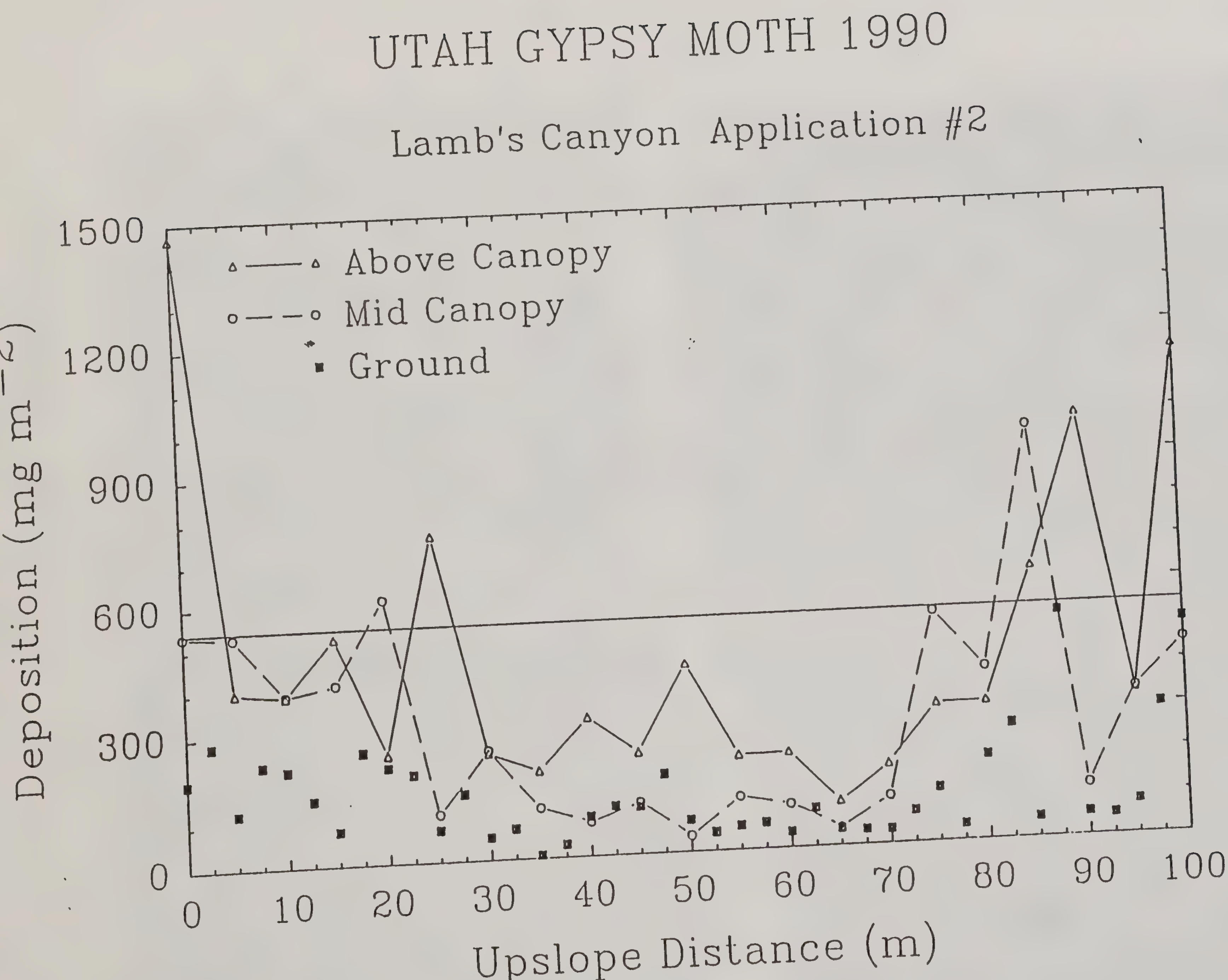


FIGURE 5



UTAH GYPSY MOTH 1990
Lamb's Canyon Application #2
Above Canopy
Mid Canopy
Ground
Deposition (mg m^-2)
1500
1200
900
600
300
0
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 6

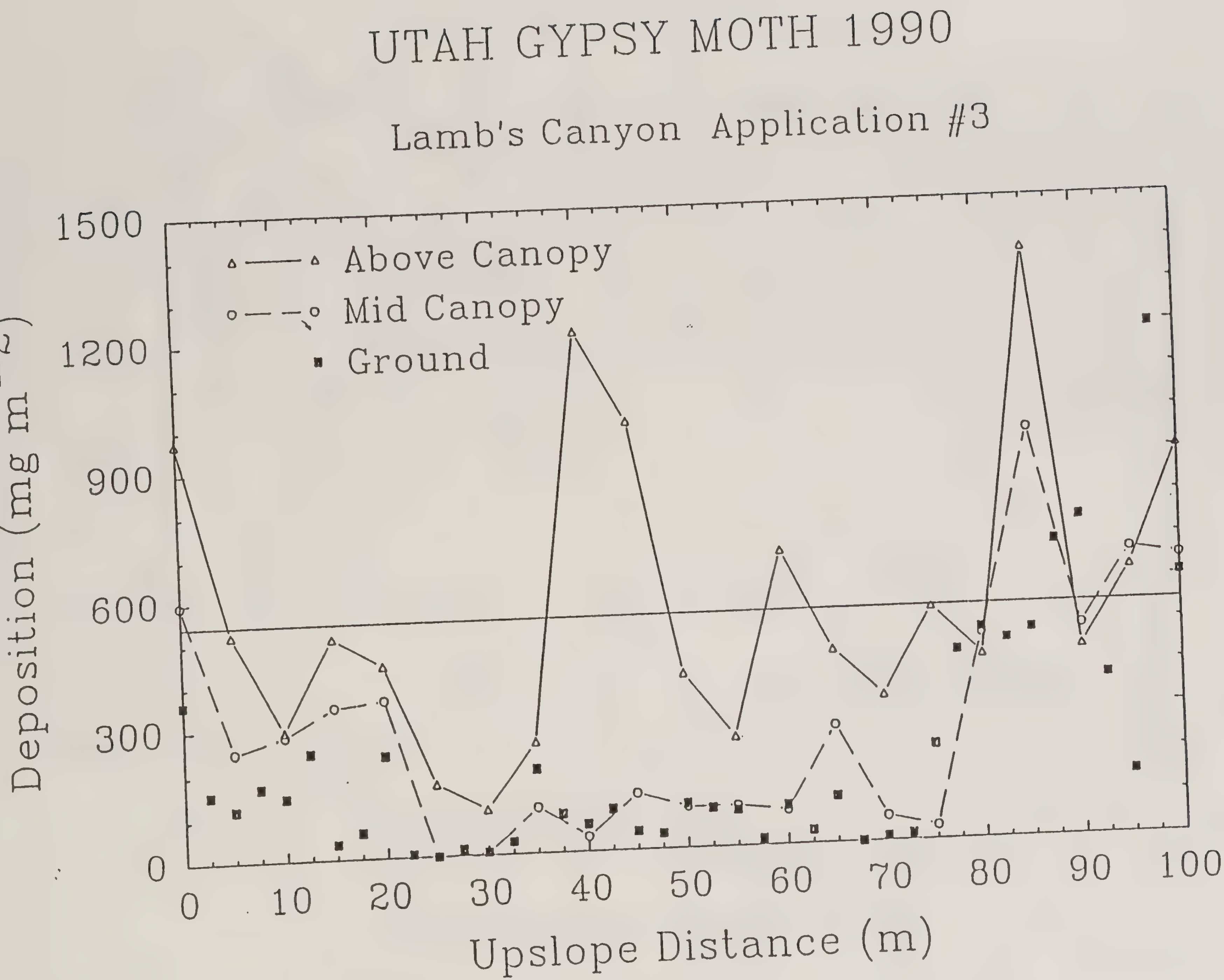

UTAH GYPSY MOTH 1990
Lamb's Canyon Application #3
Above Canopy
Mid Canopy
Ground
Deposition (mg m^{-2})
1500
1200
900
600
300
0
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 7

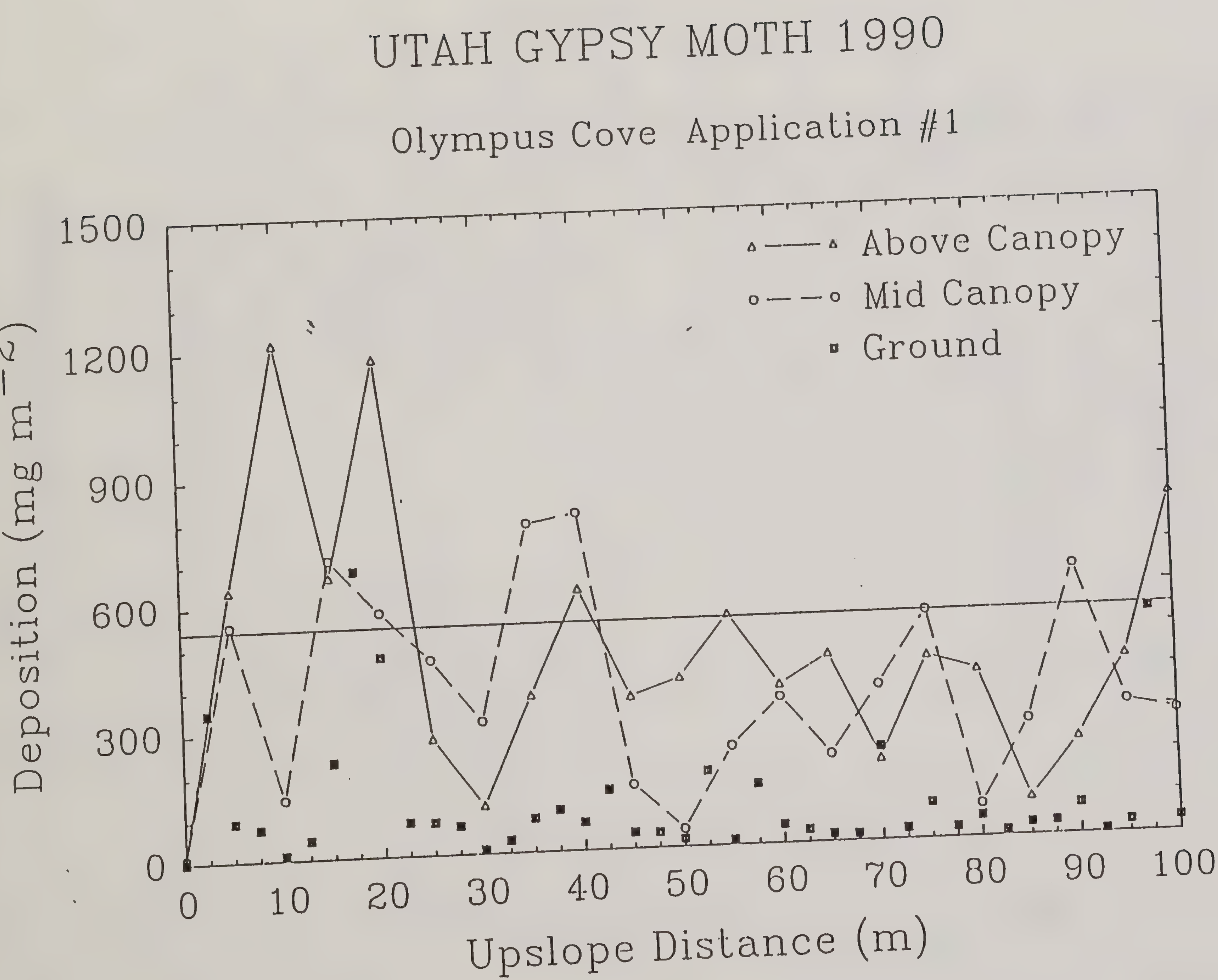

UTAH GYPSY MOTH 1990
Olympus Cove Application #1
Above Canopy
Mid Canopy
Ground
Deposition (mg m^{-2})
1500
1200
900
600
300
0
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 8

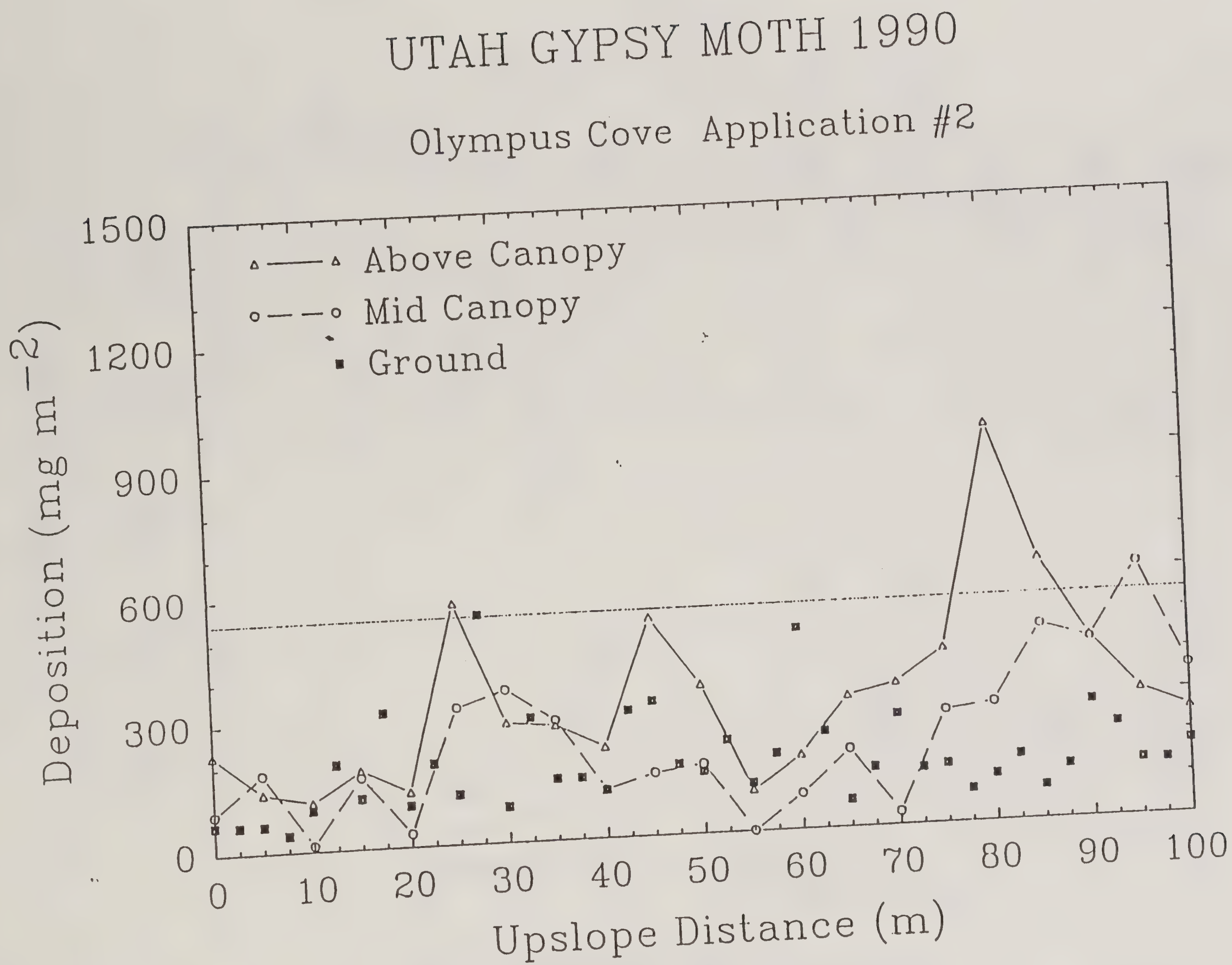

UTAH GYPSY MOTH 1990
Olympus Cove Application #2
Above Canopy
Mid Canopy
Ground
Deposition (mg m^{-2})
1500
1200
900
600
300
0
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 9

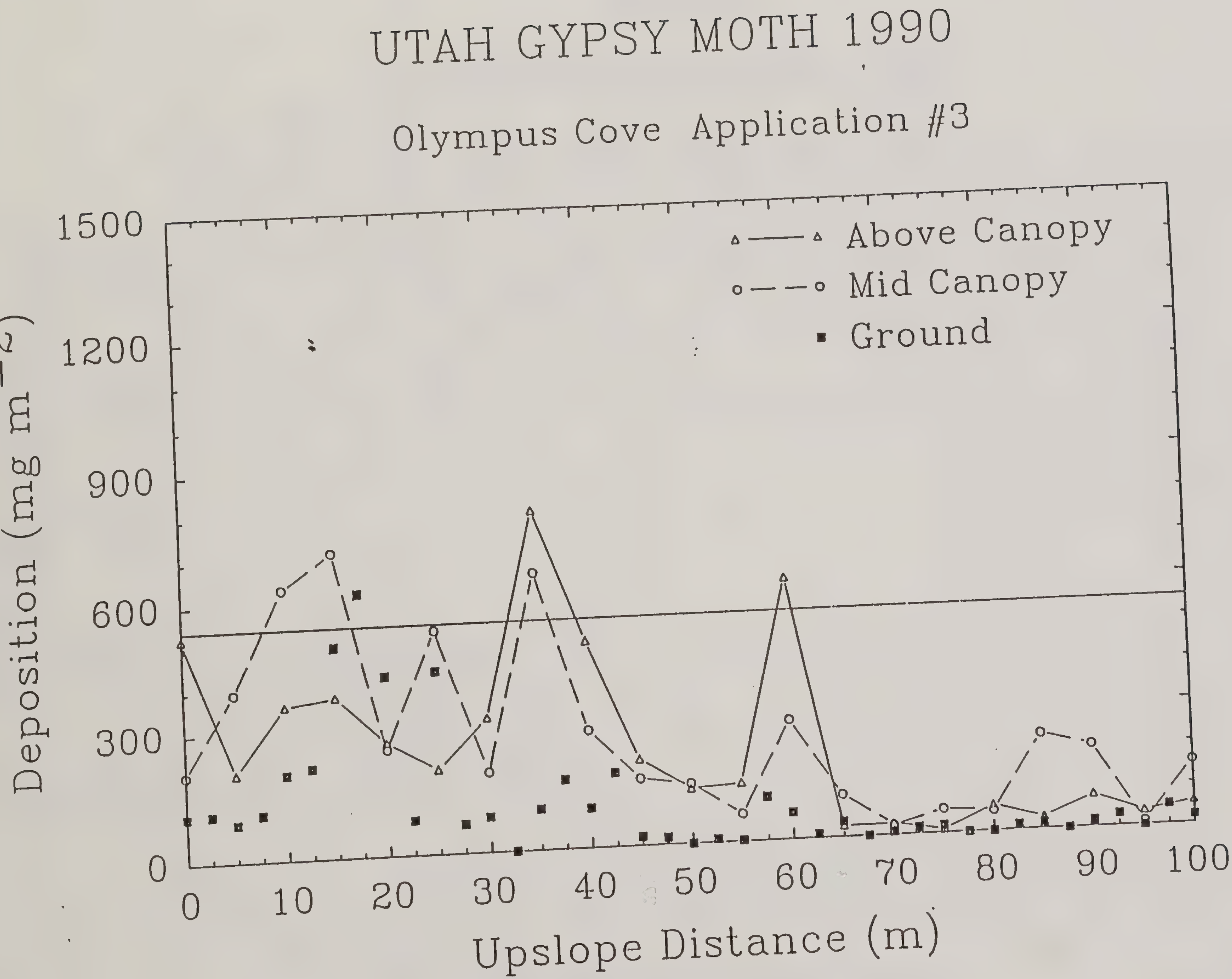

UTAH GYPSY MOTH 1990
Olympus Cove Application #3
Above Canopy
Mid Canopy
Ground
1500
1200
900
600
300
0
Deposition (mg m^-2)
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 10

UTAH GYPSY MOTH 1990

Provo Canyon Application #1

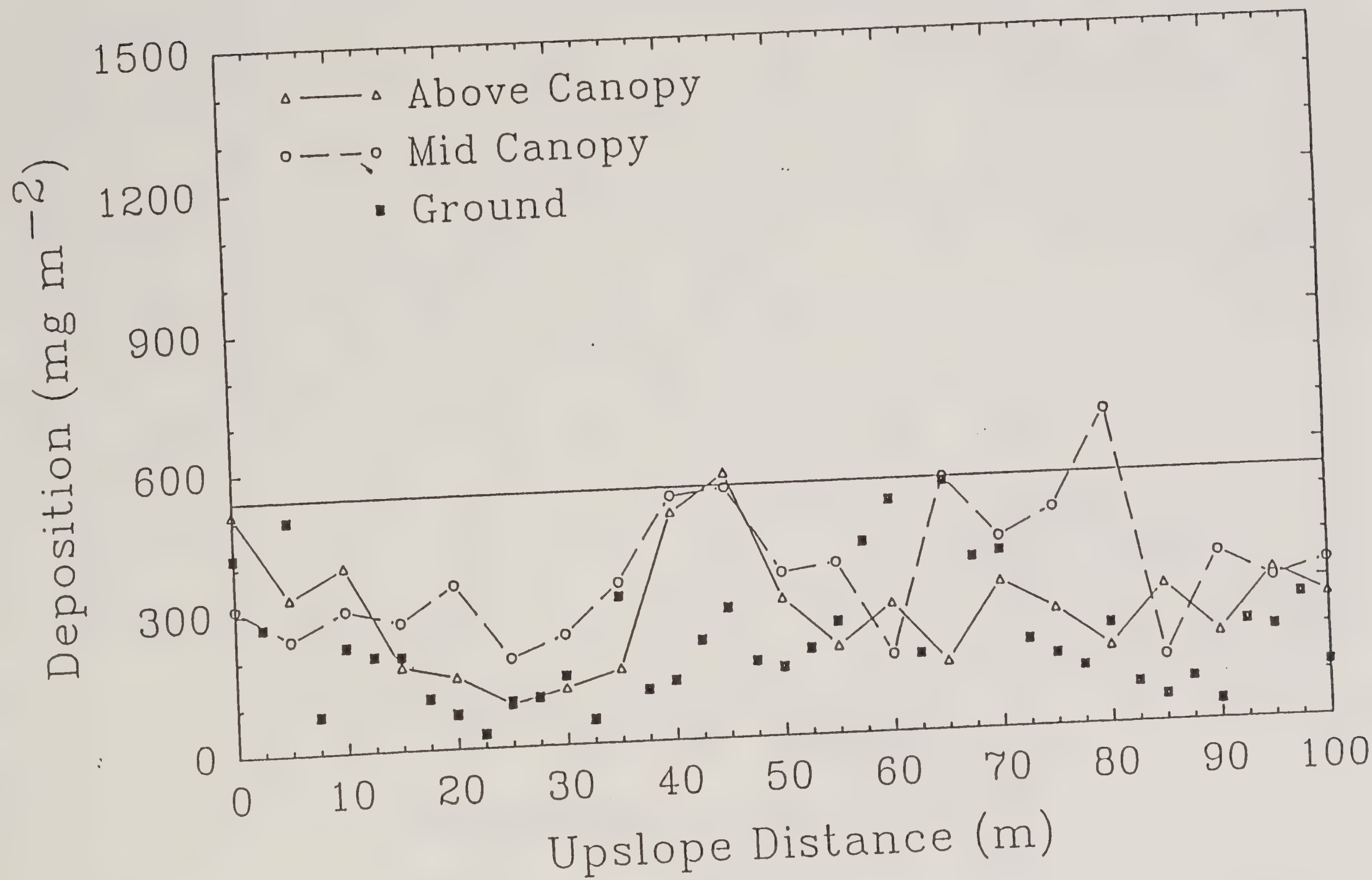
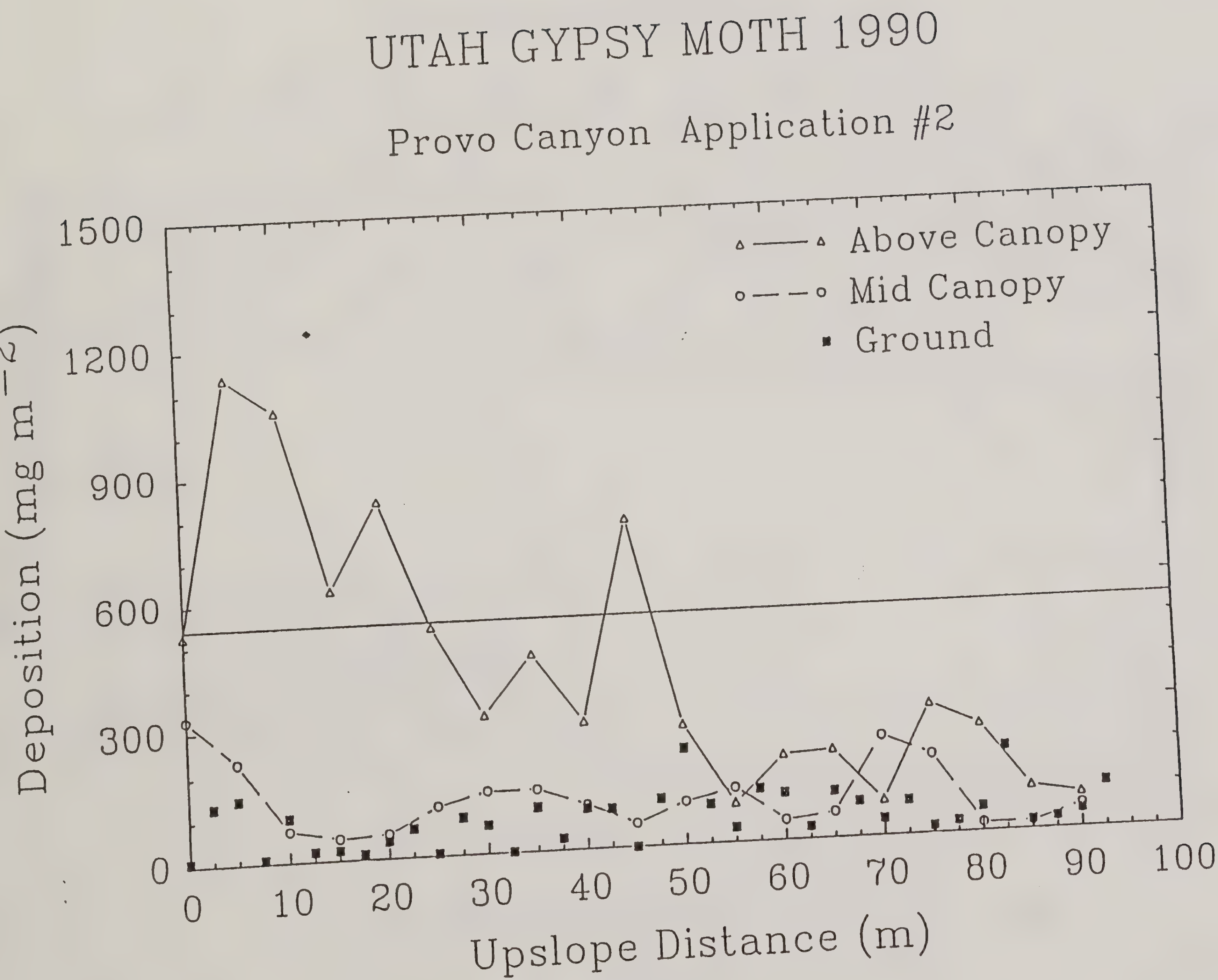
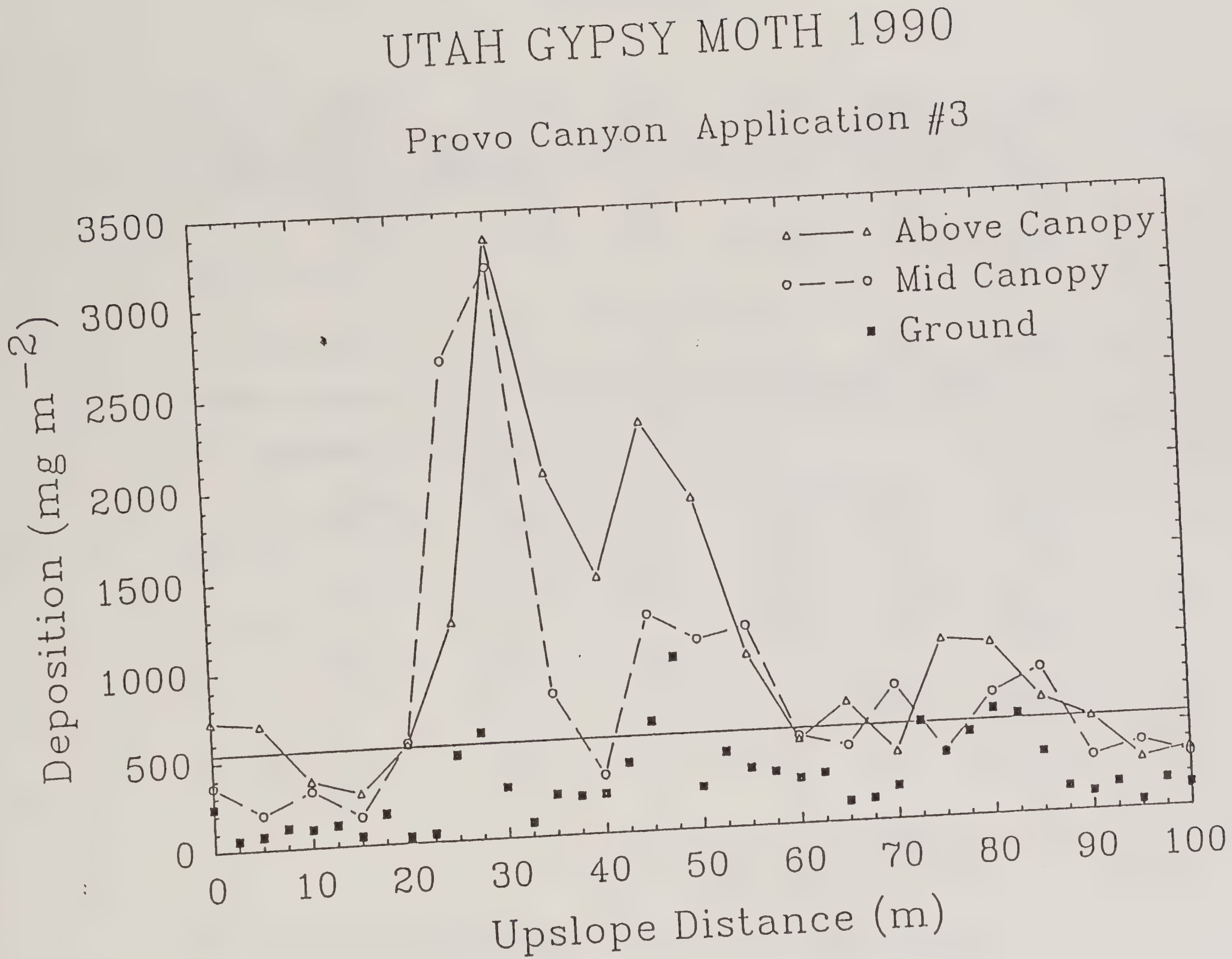


FIGURE 11



UTAH GYPSY MOTH 1990
Provo Canyon Application #2
Above Canopy
Mid Canopy
Ground
Deposition (mg m^{-2})
1500
1200
900
600
300
0
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 12



UTAH GYPSY MOTH 1990
Provo Canyon Application #3
Above Canopy
Mid Canopy
Ground
Deposition (mg m^-2)
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
80
90
100
Upslope Distance (m)

FIGURE 13

GYPSY MOTH CANOPY MEASUREMENTS USING LAI-2000 PLANT CANOPY ANALYZER

Below/Above Canopy Radiation Ratios

		Angle from Zenith (deg)				
1991 Site		7	23	38	53	68
04 Jun	Mean	0.648	0.622	0.546	0.434	0.270
	Std. Dev.	0.156	0.124	0.121	0.080	0.043
09 Jun	Mean	0.577	0.554	0.470	0.368	0.214
	Std. Dev.	0.193	0.142	0.134	0.085	0.041
14 Jun	Mean	0.444	0.423	0.331	0.228	0.120
	Std. Dev.	0.224	0.161	0.135	0.073	0.041
18 Jun	Mean	0.382	0.378	0.287	0.209	0.118
	Std. Dev.	0.240	0.166	0.128	0.082	0.047
1990 Sites						
Olympus Cove	Using 1/2 sky from 226 to 064 degrees azimuth					
18 Jun	Mean	0.255	0.305	0.243	0.196	0.150
	Std. Dev.	0.203	0.180	0.156	0.109	0.082
Lamb's Canyon						
22 Jun	Mean	0.586	0.549	0.489	0.416	0.277
	Std. Dev.	0.317	0.291	0.291	0.262	0.195
Provo Canyon	Using 1/2 sky from 190 to 010 degrees azimuth					
23 Jun	Mean	0.497	0.442	0.392	0.333	0.257
	Std. Dev.	0.313	0.261	0.241	0.172	0.125

FIGURE 14

CANOPY PENETRATION OF GAMBEL'S OAK BY AERIAL APPLICATION OF BACILLUS THURINGIENSIS ALONG THE WASATCH FRONT (1990-1991)

TEST COOPERATORS

* USDA FOREST SERVICE FOREST PEST MANAGEMENT, DAVIS, CA.
* USDA FOREST SERVICE R-4, OGDEN, UT.
* US ARMY DUGWAY PROVING GROUND, DUGWAY, UT.

OBJECTIVES

* MEASURE THE PENETRATION OF LIQUID BACILLUS THURINGIENSIS INTO GAMBEL'S OAK CANOPY WHEN AERIALLY DISSEMINATED FROM A HELICOPTER. (1990-1991)

* EVALUATE CAPABILITY OF FSCBG MODEL TO PREDICT CANOPY PENETRATION BASED ON ESTIMATES OF THE STAND DENSITY AND FOLIAGE EMERGENCE FROM ON-SITE MEASUREMENTS AND PHOTOGRAPHIC PROCEDURES. (1990)

* EVALUATE THE USEFULNESS OF THE LAI-2000 PLANT CANOPY ANALYZER IN OBTAINING THE NECESSARY VEGETATION PARAMETERS FOR INPUT TO FSCBG. (1991)

[illegible]
[illegible]

[illegible]

[illegible]

[illegible]
[illegible] 1 = [illegible]
[illegible] 2 = [illegible]
[illegible]

Bill Buzzard
September 1991

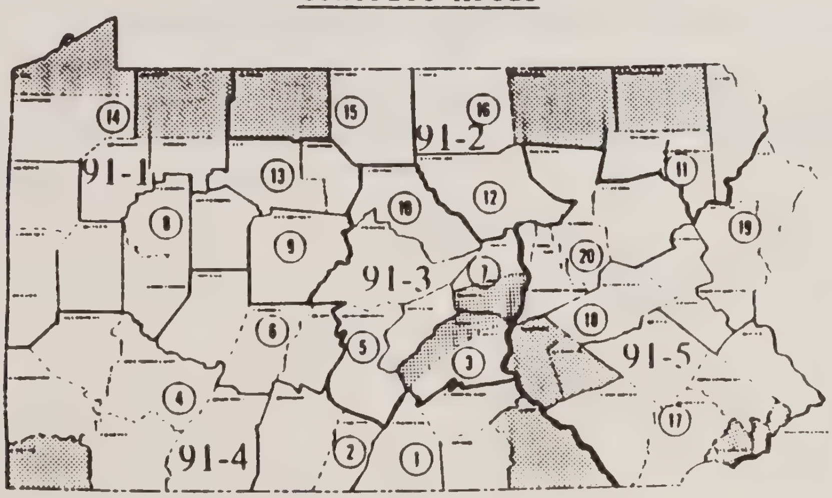
Pennsylvania Bureau of Forestry
1991 Gypsy Moth Suppression Project Summary

Option I

Acres Treated by Ownership and Insecticide

Ownership	Bt		DFB		Total	
	Acres	Blocks	Acres	Blocks	Acres	Blocks
Private	129,310	2,065	513	3	129,823	2,068
State Forest	3,109	19	103,267	149	106,376	168
State Park	7,181	71	1,403	16	8,584	87
Federal	1,111	21	0	0	1,111	21
Other	1,229	19	141	4	1,370	23
Totals	141,940	2,195	105,324	172	247,264	2,367

Contract Areas



Spray Aircraft Used

Contract 91-1
- 2 - Air Tractor AT-502
- 1 - Bell 204
- 2 - Bell 206
- 1 - Hughes 369D

Contract 91-2
- 1 - Air Tractor AT-400
- 1 - Air Tractor AT-502
- 1 - Bell Soloy (crashed)
- 2 - Bell 206
- 1 - Twin Beech D-18

Contract 91-3
- 2 - Sikorsky S55

Contract 91-4
- 1 - Bell 205
- 1 - Bell 212
- 2 - Hiller Soloy

Contract 91-5
- 2 - Twin Beech D-18
- 2 - Bell 206

Start/Stop Dates

Start: May 4, 1991 (Contract 91-4, District 1, Adams County)
Finish: May 23, 1991 (Contract 91-2, District 11, Wayne County)

Insecticides

Bt - Dipel 6AF, 20 BIU, 53.3 ounces/acre undiluted (47,100 acres)
20 BIU, 53.3 ounces/acre undiluted x 2 (453 acres)
Foray 48B, 20 BIU, 53.3 ounces/acre undiluted (40,885 acres)
20 BIU, 53.3 ounces/acre undiluted x 2 (1,847 acres)
30 BIU, 80 ounces/acre undiluted (9,877 acres)
Thuricide 48 LV, 20 BIU, 53.3 ounces/acre undiluted (41,778 acres)

DFB - Dimilin 4L, .25 ounce AI, 1 gallon/acre diluted (4,862 acres)
Dimilin 25W, .25 ounce AI, 1 gallon/acre diluted (98,564 acres)
.125 ounce AI, 1 gallon/acre diluted (1,898 acres)

Option II

Acres Treated by Cooperator, Ownership, and Insecticide

Cooperator	Private				Other			
	Bt		DFB		Bt		DFB	
	Acres	Blocks	Acres	Blocks	Acres	Blocks	Acres	Blocks
Allegheny County	6,740	130	0	0	803	12	20	1
Bucks County	3,286	47	0	0	0	0	0	0
Carbon County	28,683	79	0	0	0	0	0	0
Luzerne County	16,406	94	0	0	0	0	0	0
Montour County	385	17	0	0	0	0	0	0
Pike County	27,579	73	0	0	0	0	0	0
Pine Grove Twp.*	462	3	0	0	0	0	0	0
Totals	83,541	443	0	0	803	12	20	1

*Schuylkill County

Spray Aircraft Used

Allegheny County
1 - Bell 204
1 - Bell 206

Bucks County
1 - Bell 206

Carbon County
2 - Turbo Thrush
1 - Hughes 500

Luzerne County
3 - Turbo Thrush

Montour County
1 - Thrush S2R-600

Pike County
1 - Air Tractor 401
1 - Thrush S2R-600

Pine Grove Township
1 - Bell 206

Start/Stop Dates

Start: May 5, 1991 - Allegheny County
Finish: May 23, 1991 - Pike County

Insecticides

Bt - Dipel 6AF, 20 BIU, 53.3 ounces/acre undiluted (847 acres)
(Montour County, Pine Grove Township)
Dipel 8AF, 20 BIU, 1 gallon/acre diluted (10,829 acres)
(Allegheny and Bucks Counties)
Foray 48B, 20 BIU, 53.3 ounces/acre undiluted (72,668 acres)
(Carbon, Luzerne, and Pike Counties)

DFB - Dimilin 25W, .25 ounce AI, 1 gallon/acre, diluted (20 acres)
(Allegheny County)

DER Contract Costs - 1991 Gypsy Moth Suppression Project

Contractor	Contract	Bid Price Bt	Bid Price DFB	Acres Treated Bt	Acres Treated DFB	Extra* Bt	Extra* DFB	Actual Cost/Acre Bt	Actual Cost/Acre DFB	Contract Cost Bt	Contract Cost DFB	Contract Cost Total
Aero Tech, Inc. Clovis, New Mexico	91-1	$ 9.41 (20 BIU) 9.41 (20 BIU x 2) 11.66 (30 BIU)	$ 6.59	34,273 1,847 9,877	52,233	85	0	$ 9.91	$ 6.59	$ 455,854.87	$344,215.47	$ 800,070.34
K & K Aircraft, Inc. Bridgewater, Virginia	91-2	11.26 (20 BIU) 22.32 (20 BIU x 2)	5.93	16,617 453	24,658	387	0	11.81	5.93	201,576.00	146,221.94	347,797.94
Cordoba Helicopter Enterprises, Inc. Hightstown, New Jersey	91-3	11.74	8.78	6,612	12,942	0	290	11.18	8.40	73,901.38**	108,725.46**	182,626.84**
Evergreen Helicopters, Inc. McMinnville, Oregon	91-4	13.36	10.47	41,778	15,491	404	406	13.49	10.74	563,551.52	166,441.59	729,993.11
K & K Aircraft, Inc.	91-5	12.345	-	30,483	-	5	-	12.35	-	376,374.36	-	376,374.36
All Option I		$11.68	$ 7.28	141,940	105,324	881	696	$11.77	$ 7.27	$1,671,258.13	$765,604.46	$2,436,862.59
All Option II (Cooperator Cost)		-	-	84,344 (84,344)	20 (20)	-	-	$12.00 ($8.13)	$12.00 ($12.31)	$1,012,128.00 ($685,704.24)	$ 240.00 ($246.20)	$1,012,368.00 ($685,950.44)
Options I and II		-	-	226,284	105,344	-	-	-	-	$2,683,386.13	$765,844.46	$3,449,230.59

*Resprays and calibration adjustments--expressed as acre equivalents.
**Agreed damages of $11,175 ($0.563/acre) assessed.

Total acres - Option I = 247,264
Option II = 84,364
Options I and II = 331,628

Leo Cadogen
September 1991

FOREST PEST MANAGEMENT INSTITUTE'S REPORT TO U.S.F.S NATIONAL STEERING COMMITTEE FOR APPLICATION OF PESTICIDES - EASTERN DEFOLIATORS

BLACKSBURG VIRGINIA 10TH & 11TH SEPTEMBER 1991

COMPILED BY B.L. CADOGAN
FORESTRY CANADA
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SAULT STE. MARIE ONT.
CANADA P6A5M7

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INTRODUCTION

The summaries presented herein are intended to keep researchers within USDA-FS abreast of work being conducted at FPMI and to foster and encourage more collaborative dialogue and research between the two organizations.

Research Activity: Spray Distribution, Deposition and Persistence of B.t.(k) in a Hardwood Forest in W. Virginia, U.S.A., During the 1991 Gypsy Moth Spray Program
Principal Researchers: K.M.S Sundaram and A. Sundaram

The distribution, deposition, persistence and biological activity of spray deposits resulting from aerial applications using helicopter and fixed-wing aircraft were examined in mixed hardwood forests of W. Virginia, USA using undiluted commercial preparations of *Bacillus thuringiensis* var. *kurstaki* [*B.t.*(k)].

In the first study, four blocks (30 acres) were sprayed with Foray 48B (Novo Biocontrol, Danbury, CT) at 36 BIU in 96 oz/acre when the gypsy moths were the 2nd instar, using a Bell helicopter fitted with AU7000 rotary atomizers. Spray droplets were collected on water sensitive cards placed at ground and canopy levels to determine the size spectra of the spray cloud at the two sampling heights. Spray droplets were also collected on oil surfaces to determine directly the spread factor values for the droplets. Natural foliage and artificial samplers at mid-crown level were collected up to 96 h postspray to measure the reduction of the efficacy of *B.t* (k) with time.

In the second study, two commercial preparations of *B.t.*(k), *viz*. Foray 48 B and Thuricide 48 LV (Sandoz, Des Plaines, IL), were applied undiluted when the insects were at 4th instar levels, at maximum allowable label dosage rates (36-40 BIU in 96-107 oz/acre) over 4 blocks (2 blocks/formulation) using a fixed wing aircraft fitted with six Micronair AU5000 atomizers.

Initial deposits and persistence of *B.t.*(k) activity are being assessed on oak foliage up to 4-d postspray by three methods of bioassay using the 4th instar gypsy moth larvae: (a) directly feeding larvae of the contaminated foliage, (b) bioassay on diet mixed with homogenized foliage and (c) force-feeding larvae foliar extracts using a buffer at pH 12. The bioactivity on a unit area of the target foliage (natural and artificial) were computed from the percent mortalities to estimate deposit/cm^2 on the target surfaces.

Initial deposits and persistence were also assessed on artificial samplers placed at the canopy and ground levels, using the method of force-feeding of extracts.

The droplet density (droplets/cm^2), droplet size spectra (NMD and VMD) and percent deposition *vs* meteorological factors that existed, application methods (helicopters *vs* fixed-wing aircraft) and atomizers used and formulation types applied are being critially analyzed. Similarly, the variation in initial foliar deposits (expressed in IU/cm^2 of target surface) in terms of the above variables will be studied and documented. The differences observed in total *B.t.*(k)

activity due to spores and crystals, persistence characteristics of the toxin, its DT_{50} etc., with the variables will be examined and accounted for. A comparison of the persistence of the crystal toxin (60 kDa) on artificial and natural surfaces will be made in order to understand the factors affecting B.t.(k) stability in the forest environment.

All facets of the research conducted in this field study including the effectiveness of treatment (2nd instar vs 4th instar) and the impact, if any, on nontarget fauna, will be published in due course in cooperation with the USDA cooperators.

Environmental Impact of Forestry Pesticides
Stephen B. Holmes (Project Leader)

a) Research Activity: Terrestrial Vertebrate Ecology
Principal Researcher: Rhonda C. Milliken

Ms Milliken is temporarily on assignment with the Canadian Wildlife Service (CWS) in British Columbia, where she is coordinating research between the CWS, Forestry Canada and the B.C. Ministry of Forests. Specific studies include the impact of various forest cutting practices on songbird communities and the effects of herbicide treatment on songbird habitat and diversity.

b) Research Activity: Terrestrial Invertebrate Toxicology
Principal Researcher: Kevin N. Barber

Studies are focusing on the toxicology of next-generation pest control products, in particular B.t. and viruses, and their impact on non-target invertebrates.

At present, non-target insects are collected in the field, reared in the laboratory and bioassayed. DNA probes are being employed to screen for viral infectivity.

c) Research Activity: Soil Microcosms
Principal Researchers: Stephen B. Holmes and Janet A. Addison.

The effects of microbial pesticides on soil organisms and processes are being studied in model laboratory ecosystems. Earthworms and Collembola bioassays with B.t. are being conducted.

d) Research Activity: Aquatic Toxicology
Principal Researchers: David P. Kreutzweiser and S.B. Holmes

The effects of trichlopyr ester on aquatic organisms are being investigated in laboratory flow through bioassays. Trichlopyr will also be applied to a forest stream and to lake enclosures to measure impacts on fish survival and growth, on macroinvertebrates and on periphyton communities.

During 1990-91 studies were conducted using laboratory flow through bioassays and outdoor stream channels to determine the behavior and lethal effects of a new insect growth regulator, RH5992, on stream insects.

Research Activity: Insecticide Toxicology
Principal Researcher: Blair V. Helson

In 1991 research was conducted on the following defoliators

a) Spruce budworm *Choristoneura fumiferanae*

In the laboratory RH5992, an experimental insecticide (Rohm & Haas) was tested to determine a)its residual toxicity; b)the effects of exposure time, formulation, larval instar, wet foliage, types of foliage, temperature and field collected larvae compared with laboratory reared ones, on its toxicity; and, c)the effects of the material on larval foliage consumption.

MK-244 formerly MK243 (supplied by Merke, Sharpe & Dohme) was investigated to determine its residual toxicity, its toxicity via topical application and ingestion and its effects on food consumption.

b) Forest tent caterpillar *Malacosoma disstria*

In the lab, the feeding deterrence of red maple (*Acer rubrum*) when compared with sugar maple (*A.saccharum*) was investigated.

c) Pine false webworm *Acantholyda erythrocephala*

In collaboration with D.B. Lyons, Forestry Canada Ont. Region, tests were conducted to determine the toxicity of RH5992, MK244 and Dimilin against the species.

Field trials were also conducted with permethrin, carbaryl, and Dimilin on red pine (*Pinus resinosa*) using mistblowers.

d) White Pine Weevil *Pissodes strobi*

Laboratory tests were conducted in collaboration with P. deGroot (FPMI) to determine the influence of application timing and the efficacy of mistblower treatments using permethrin and methoxychlor on jackpine, *Pinus banksiana*.

e) Seedling Debarking Weevil *Hylobius congener*

A field trial was conducted (in collaboration with Bruce Pendrell, Forestry Canada, Maritimes and R. Allen, Stora Forest Industries) to determine the efficacy and investigate any phytotoxicity of permethrin on white (*Picea glauca*) and red spruce (*Picea rubens*) seedlings. This research was conducted in Nova Scotia.

f) Other Species

Laboratory trials were conducted to determine MK244's spectrum of activity against the Hemlock looper (*Lambdina fiscellaria fiscellaria*), Gypsy moth (*Lymantria dispar*), white marked tussock moth (*Orgyia leucostigma*), Forest tent caterpillar (*M. disstria*), black army cutworm (*Actebia fennica*), spruce budworm

(C. fumiferana) and European sawfly (Diprion Percyniae).

Research Activity: Insecticide Formulations
Principal Researcher: Alam Sundaram

During 1991, research continued on the studies outlined in the 1990 report i.e., research on the physiochemical aspects of pesticide performance and factors contributing to the rainfastness of pesticides.

Participation in nine field trials in W. Virginia (see Sundaram and Sundaram elsewhere in this report) provided evidence that suggests spread factors cannot be accurately determined in large scale field trials and that spread factors should only be determined under controlled laboratory conditions.

Research Activity: Efficacy of B.t. Timed Expressly to Preserve Spruce Budworm Larval Parasitoids in a Spruce-Fir Forest
Principle Researchers: Leo Cadogan, Kees Van Frankenheyzen and Vince Nealis*

A field trial, similar to that reported in 1990, was conducted in NW Ontario to determine the efficacy of B.t. when it was sprayed later than usual in an effort to minimize impact on larval parasitoids of SBW. In 1991 Foray 48B was used in place of Dipel 352(16L) and the budworm populations targeted were moderate, (mean = 21 to 35 larvae/branch) instead of high (>40 larvae/branch).

The application that was timed to enhance larval parasitism reduced the spruce budworm populations significantly more than the regularly timed one on both host species. (93% vs 71% on balsam fir and 73% vs 52% on black spruce).

The incidences of defoliation on both species are at time of writing being evaluated; however there are indications that both the regularly timed and the late application of Foray 48B prevented any significant defoliation.

These preliminary results suggest that B.t. could be successfully incorporated into an integrated management program of moderate Sbw populations, where the pest could be controlled satisfactorily, and the beneficial insects preserved without sacrificing the host trees' foliage.

* Forestry Canada, Ontario Region

Research Activity: Application of Viral Insecticides in 1991
Principal Researcher: John C. Cunningham

Gypsy Moth Lymantria Dispar

A total of 14 plots, located in Simcoe District, Ontario each 10 ha in area were treated with Gypchek supplied by the USDA Forest Service and an 80 ha block in the arboretum of the Royal Botanical Gardens, Hamilton, Ontario was treated with Disparvirus produced at the Forest Pest Management Institute (FPMI) in a

collaborative study involving Forestry Canada, the USDA Forest Service and the Ontario Ministry of Natural Resources. In addition, 7 check plots were monitored, and 3 plots were operationally sprayed with Foray 48B, a *Bacillus thuringiensis* formulation.

Prespray egg mass counts ranged from 3,000/ha to 15,405/ha. Two applications of virus were made 3 days apart. Five replicated plots were treated with 1.25 x 10^{12} PIB/ha (total 2.5 x 10^{12} PIB/ha)in 12.5% molasses, 6% Orzan LS, and 2% Rhoplex B60A sticker in an emitted volume of 18.8 L/ha; 3 replicated plots were treated with the same dosage in 25% Dipel-176-carrier-vehicle, 73% water and 2% Rhoplex sticker in an emitted volume of 5.0 L/ha and 3 replicated plots were treated with the same dosage and tank mix in an emitted volume of 2.5 L/ha.

Spraying commenced on May 20th and finished on May 25th. The FPMI Cessna Agtruck fitted with 4 AU4000 Micronair units was used for the 5.0 L/ha applications and the same aircraft fitted with 8 AU5000 atomizers was used for the high volume application. Larvae were predominantly in the second instar at the time of the first application and, in some of the plots, were predominantly in the third instar by the time of the second application.

The assessment is currently underway and data from burlap traps and defoliation surveys are being analyzed. Fall egg mass counts will be conducted in late October. Preliminary observations indicate that there were no major differences in pupal counts under burlap between the high dosage/high volume (18.8L/ha) application in molasses and Orzan and the low dosage/low (5.0 L/ha) application in emulsifiable oil. The low dosage/ultralow volume (2.5 L/ha) application in emulsifiable oil appeared inferior. Defoliation of oak in virus-treated plots ranged from 35% to 81%, from 10 to 29% in Foray-treated plots and from 17 to 81% in check plots. Defoliation greater than 40% is considered unacceptable; only two Gypchek-treated plots, high volume/high dosage, met this criterion. The heavy defoliation of oak is attributed to too late an application; between 1988 and 1990 applications in Ontario were made on predominantly first instar larvae. However, no definitive conclusions regarding the impact of these treatments can be reached until results from fall egg mass counts have been analyzed.

Redheaded Pine Sawfly *Neodiprion lecontei*

Between 1976 and 1990, 590 plantations with a total area of 4,855 ha were treated with Lecontvirus in Ontario and Quebec. In 1991, sufficient Lecontvirus was distributed to clients in an emulsifiable oil suspension to treat 420 ha. An experiment was conducted this year with a wettable powder formulation of Lecontvirus applied with a mistblower at 20.0 L/ha on larvae which were 39% third instar and 61% fourth instar. Dosage was 10^{10} PIB/ha. Three plots with a combined area of 4 ha were treated and an additional plot was left unsprayed as a check. First mortality was observed 16 days post-spray in the treated plots, but it was not until 30 days postspray that peak mortalities of 62.5, 86.4 and 90.0% were attained. Defoliation of some of the 0.5 to 1.0 m red pine trees planted in 1988 was severe. It was concluded that the virus was applied too late in the development cycle of the insect. Every effort should be made to detect outbreaks early in the life-cycle of redheaded pine sawfly and apply the virus before larvae reach their fourth instar. Also, aerial applications of Lecontvirus are recommended over ground spray applications for a variety of

reasons.

Research Activity: Pheremone Research on Eastern Hardwood Insects
Principal Researcher: Gary G. Grant

Gypsy Moth *Lymantria dispar*

We are attempting to develop a pheromone monitoring system for the gypsy moth in Ontario using USDA low release rate lures. We are correlating trap catch with egg masses and/or defoliation in plots throughout Ontario. We are also using pheremone monitoring traps as a post-treatment assessment tool (population sampling of adults) to evaluate the efficacy of control treatments such as virus of B.t. sprays. Last year we had good correlation between trap catch and egg masses, and in the assessment study traps catches in control plots were substantially higher than in virus treated plots.

Other Defoliators

In conjunction with FIDS, we have been attempting to develop a pheremone monitoring system for the oak leafshredder (oak leaftier in the USA), *Croesia semipurpurana* to replace egg sampling as a means of forecasting population levels in Ontario. In the Maritimes, pheromone traps are used for detection and to discriminate between damage (infestations) cause by the oak leafshredder and the oak olethreutid leafroller, *Pseudexentera spoliana*. In 1988, the latter species caused an average 68% defoliation over 23,000 ha in Nova Scotia. The sex pheromone of this species was recently identified (Grant et al 1991, Can Ent, in press) and pheromone traps are now deployed across the Maritimes to monotor oak stands for this pest in conjunction with similar monitoring for the oak leafshredder.

As part of the oak olethreutid leafroller study, the sex pheromone of the aspen leafroller, *Pserdexentera oregonana*, was identified and is available for monitoring traps. The study demonstrated that these similar species are attracted to different pheromones.

Research Activity: Evaluating RH5992 against Spruce Budworm in Northern Ontario
Principal Researchers: A. Retnakaran and L. Smith

During 1991 two formulation viz RH5992-2/OS (oil) and RH5992-2F (water) were field tested using ground applications (back pack mistblower). Four dosages ranging form 17.5 to 70 g AI/ha in a volume of 5 L/ha (500 ml/plot) were tested. The research was conducted in a young, 2 to 10 m tall, naturall regenerated spruce-fir plantation. Each dosage was replicated three times using plots 0.1 ha (50m x 20 m) in size. Thirty balsam fir trees were randomly selected as sample trees in each plot.

Preliminary results indicate there was no significant difference in efficacy between formulations with population reductions ranging from 86 to 95 %.

Defoliation in the treated plots ranged from 15 to 20 % while that in the check plots averaged 60%.

Plans are to field test RH5992 using aerial applications in 1992.

Forestry Canada Forêts Canada

19 September 1991

Mr. Harold Flake
USDA - FS Regional Office
1720 Peach Tree Rd. N.W.
Suite 925 North
Atlanta, GA
U.S.A. 30367

Dear Harold:

Regarding our discussion in Blacksburg, Va. on a weather monitoring system, I have enclosed some literature on one of our systems.

The enclosed diagram attempts to outline the system and the narrative below describes the components. Actually this system is very simple, yet very reliable; but if you prefer, it can be made to be very complex, using Radiotelemetry that allows data transfer from a remote data-logger to a base station etc.

For now, we'll deal with what's in our league; a simple station.

1.a) MAST

I would recommend a lightweight, aluminum high tensile, triangular type as shown in the photocopy. These come in 10 ft. units but you'll probably need a Tilt base unit and a Top unit section plus the required number of centre sections to give you your required height.

Source: Texas Towers. Call for the price/unit.

....2

Forest Pest Management Institute
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7
705-949-9461
705-759-5700 Fax

Institut pour la répression des ravageurs forestiers
C.P. 490
Sault Ste. Marie, Ontario
P6A 5M7
705-949-9461
705-759-5700 Fax

Canada

2.b) SENSORS

b) 1-05103 Wind Monitor anemometer/wind vane to measure wind speed and direction. This one starts to register at 1.3 mph. If you require a more sensitive threshold I would recommend using 1-12005 Gill Microvane Assy.

Source: R.M. Young Co., 2801 Aeropark Drive, Traverse City, MI 49684 - Tel. (616) 946-3980.

c) 1-107 Temperature probe to be used at the top of the mast. Order with sufficient cable to reach the instrument shelter.

Source: Campbell Scientific Inc., P.O. Box 551, Logan, Utah 84321, Tel. (801) 753-2342.

d) 1-41301-5 Radiation Sheld. This prevents direct sunlight from influencing the probe and giving false readings.

Source: R.M. Young* or Campbell Sci. Inc.

e) You'll need some cross arms as shown in the diagram. You can easily make them yourself, or order them from Campbell Sci. Note however that the sensors vary in size, therefore the diameters of the short ends of the crossarm will differ according to each sensor. Buy the sensors first and then make the cross arms.

f) 1-207 RH & Temp probe or you can use 1-HPM 35C if you prefer. This is one unit that allows you to measure temp at the low level and RH at the same time. Using Temp at the top and low level you can determine lapse, inversion or neutral air stability.

Source: Campbell Scientific

g) 1-41004-5 Gill Radiation Shield. This is required for the 207 or HMP35C unit because their diameters differ from the 107 probe.

Source: Campbell Sci. or R.M. Young*.

.....3

h) <u>1-TE525 Tipping Bucket rain gauge</u>. This is optional. It registers precipitation - how much and when it fell.

Source: Campbell Sci.

i) <u>1-237 Wetness sensing grid</u>. This is also optional. This simulates what periods the foliage is wet and how wet it is. Make sure you order it with enough cable to reach the instrument shelter.

Source: Campbell Sci.

3. <u>DATA LOGGING</u>

j) You'll need an instrument shelter. I'd recommend a regular Stevenson screen. However, Campbell Sci. does sell one which might be easier to carry around. You can also make your own. I did!

<u>1-CR21 x or CR10 data logger</u>. The latter requires a lap top to program it but you can avoid this by purchasing a separate keyboard and display. I prefer to use the lap top. These can be programmed to sample the sensors every sec or twice/second or every 2 seconds etc. as required. The data can be processed to give a mean $\pm$SD for each sensor over given periods e.g. The rain gauge would be every hour and windspeed would be every minute or every 2 minutes as you require. These data are stored until the memory is full and then the data must be dumped elsewhere; either on tape or directly to a disc.

Source: Campbell Sci. Call for prices.

<u>1-RC235 Cassette Recorder</u>. This is the cheapest and most convenient form of field data storage but I'm not fully satisfied with it. They are coming up with expandable memories in the CR21X and CR10 and this might be a better way to go.

<u>1-HR5 Brother Printer</u>. This operates on a 12V source and gives an immediate but limited hard copy of the data. We use this at spray time because it allows the supervisor to see if conditions are OK for spraying.

Source: Any Brother Agent. Might need modifying.

1-MSX 10R Solar panel, Mounts & Regulator. This is optional. I would recommend it if you are going to use a 12V automobile or marine battery as a power source.

Source: Campbell Scientific.

Note: If you are going to use the system in the field be prepared to protect the cables from porcupines and other rodents.

If you have any questions do give me a call. If Jack Barry has funds perhaps I can arrange to have a technician visit with a system and demonstrate it.

Yours sincerely

Leo

Leo Cadogan

c.c. Dr. Jack Barry
E. Caldwell

[illegible] TREA[illegible]

The general [illegible] recreational [illegible] in [illegible] ailing 5,[illegible]10 acres and [illegible] twenty-five acres. Description of [illegible] this report [illegible]

[illegible] 1991 [illegible] operations [illegible] 3 [illegible] prog[illegible] [illegible] the [illegible]

[illegible]

[illegible] Fire [illegible] [illegible] of [illegible]

Tony Chiotakis
September 1991

N. C. DEPARTMENT OF AGRICULTURE
1991 GYPSY MOTH TREATMENT OPERATIONS

The gypsy moth treatment program in North Carolina consisted of aerial treatment on six sites totalling 7,740 acres and ground treatments on four sites totalling twenty-five acres. Descriptions of the spray sites are included in attachment one of this report.

The 1991 treatment operations included several significant changes from previous years. The contract proposal was modified to include a provision for a multi-year contract at the Department's discretion. Essentially, this provision guarantees the bid price for two years. Previously, contract proposals were solicited for a one year period. Sixty-nine proposals were distributed with seven contractors responding. This was a two-fold increase over the number of contractors responding last year.

The second change involved the spray delivery system. Conventional flat fan nozzles were permitted for undiluted Bt applications on aircraft with operational speeds in excess of 150 MPH. Previously, only rotary atomizers were used for undiluted Bt applications. Information obtained from spray characterization trials in March of 1991 (Bridgewater III) gave acceptable results using this type of spray delivery system. Information and results of the spray trials are included with this report. This year also marked the first year single and double applications were made to selected sites.

Four sites totalling 6,120 acres received only one application. The reasons for this decision were based primarily on the sites proximity to existing quarantine areas, the advancing front, and money. Treatment dollars were, and still are, in extremely short supply.

This season's spray contract was awarded to K & K Aircraft of Bridgewater, Virginia at a bid price of $3.299/AC. This proposal included providing one Turbine Twin Beech aircraft (N38L), one Cessna high wing aircraft and associated equipment, and ground crew for loading and support.

Bacillus thuringiensis (Bt) was used on all aerial application sites. The NOVO/Nordisk product, Foray 48B, was selected for this year's treatment program. Past control results were excellent with this material. Five thousand sixteen (5,016) gallons of material were purchased at a price of $11.64 per gallon.

The material was delivered in 264 gallon mini-bulk containers.

The spray aircraft was calibrated to 80 ounces (30 BIU) of undiluted Bt per acre. Characterization trials indicated an acceptable swath of 100 feet. Extending beyond this length resulted in an unacceptable variation in the swath. Flat fan 8006 nozzles with a fifty mesh in line filter were used on the spray boom.

Treatment operations on the sites receiving two applications were conducted on April 11th and 24th. The single application sites were treated on April 16th, 17th, and 18th. Foliage development across the sites ranged from 30% at the beginning to approximately 60% at completion. Larval development ranged from approximately 50-60% 2nd instar to 10-20% 3rd instar. No major mechanical, safety, or logistical problems were encountered during the operation. However, one spray block unfortunately received an unexpected 10 inches of rain approximately 30-36 hours after treatment.

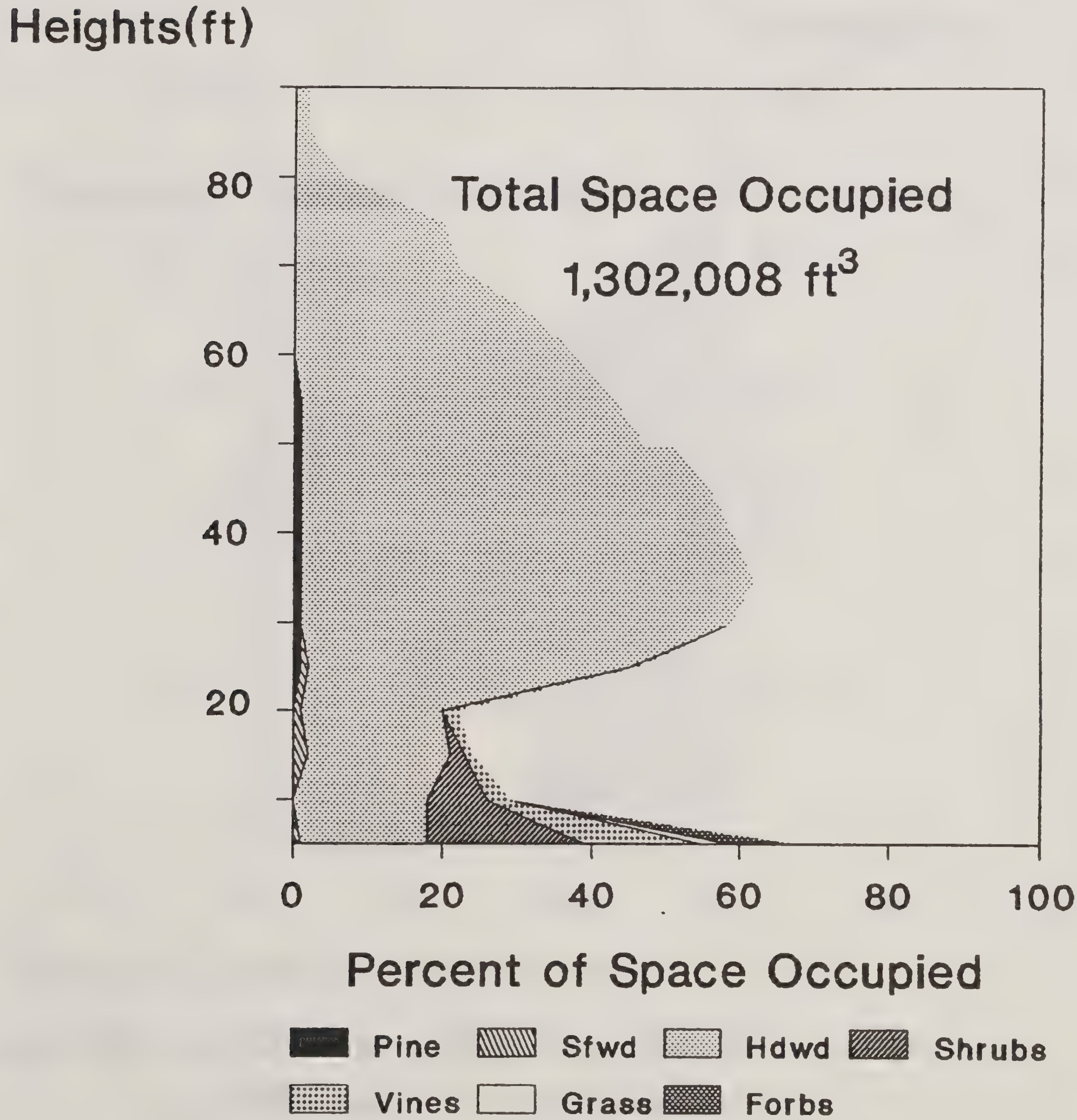
Treatment evaluations are continuing at this time. Moth catches in all but two sites are much lower with three sites not reporting any catches thus far.

Activity for the remaining season included the continuation of male moth trapping and egg mass survey in selected sites. If current budget reductions and spending restraints continue or decrease, the outlook for treatment activities next year appear slim.

GYPSY MOTH TREATMENTS IN VIRGINIA--1991

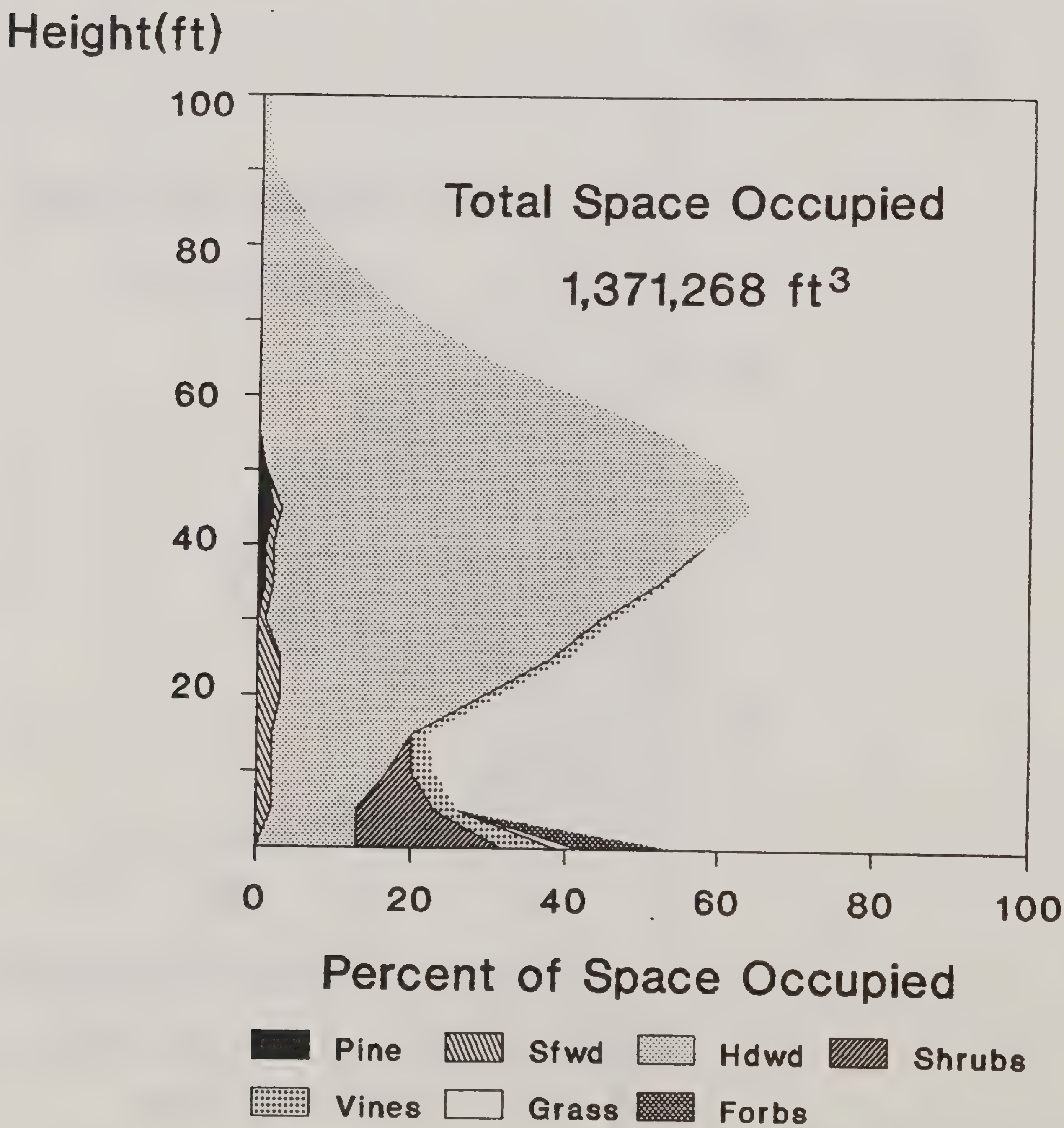
Agency	Bt	Dimilin	Gypchek	Mating Disruption	Sterile Insects	Total	Aircraft Used
Virginia S/P	30,358	60,472	0	0	0	90,830	DC-3; Twin Beech; Bell 212, 204, 206, Hughes 500
Virginia S/P AIPM	21,099	39,760	1,341	3,544	221	65,965	DC-3; Twin Beech; Thrush; Cessna 206
Ft. Belvoir/Vint Hill	1,710	2,394	0	0	0	4,104	Same as Virginia S/P
Quantico Marine Base	4,584	9,827	900?	0	0	15,311	Bell 47 Soloy;
George Washington NF	2,378	0	0	291	90	2,759	Bell 47 Soloy; Cessna 206
Shenandoah Natl. Park	5	965	210	0	0	1,180	Bell 47 Soloy
Blue Ridge Parkway	0	150	246	0	0	396	Bell 47 Soloy
Total	60,134	113,568	2,697	3,835	311	180,545	

Vegetation Profile
Oak/Hockory 31-40

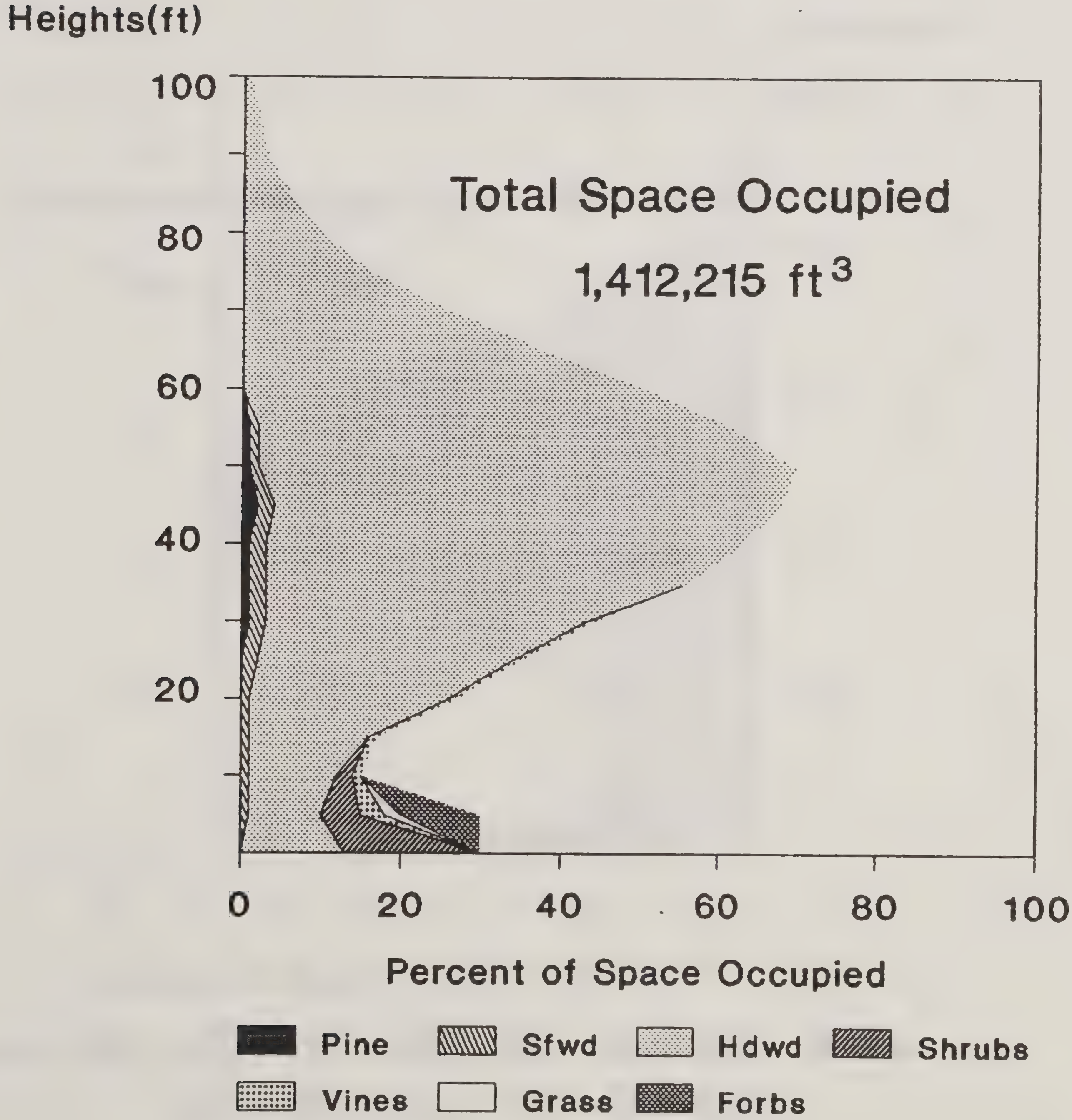


SE/FIA

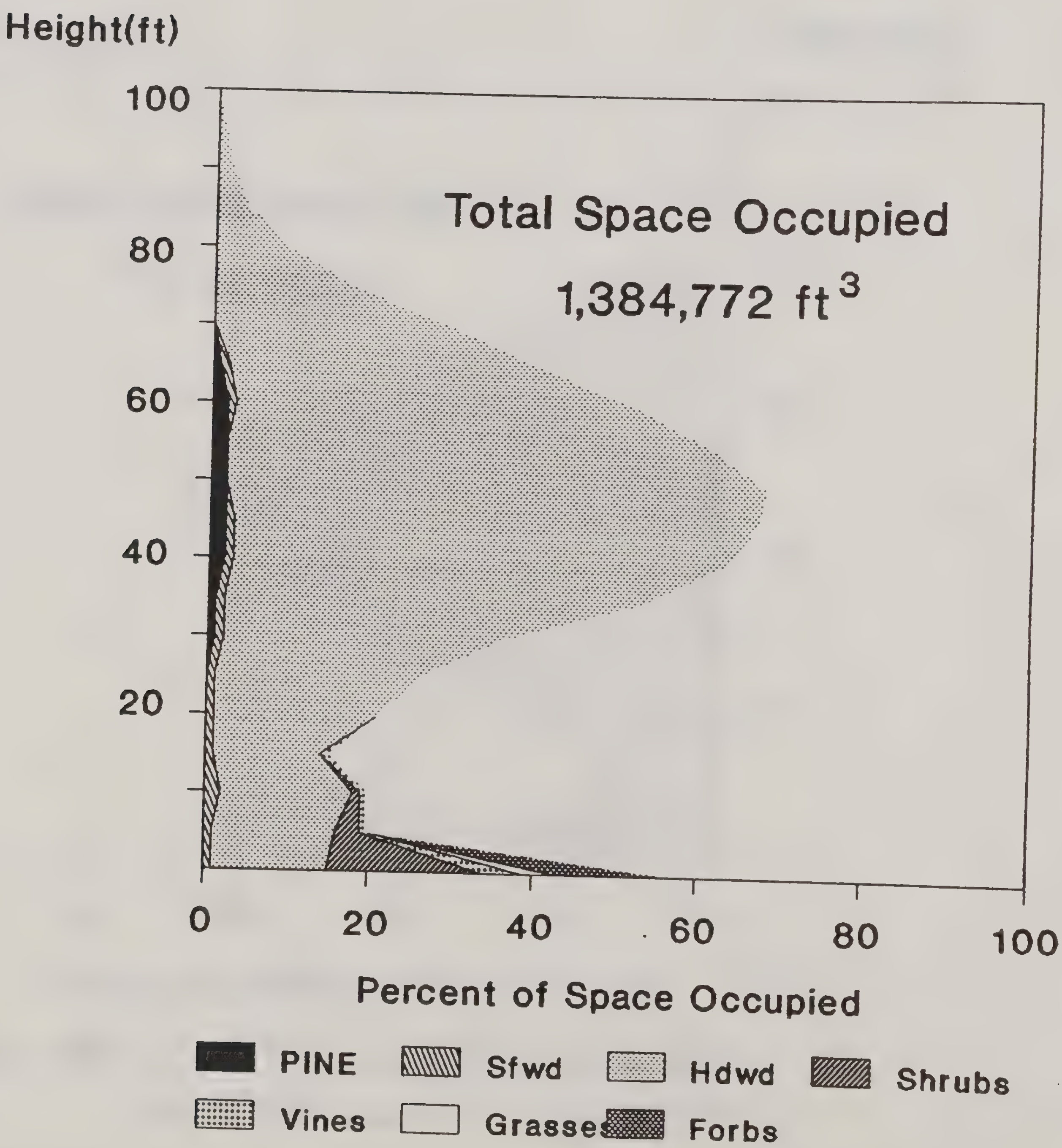
Vegetation Profile
Oak/Hickory 41-50



Vegetation Profile
Oak/Hickory 51-60

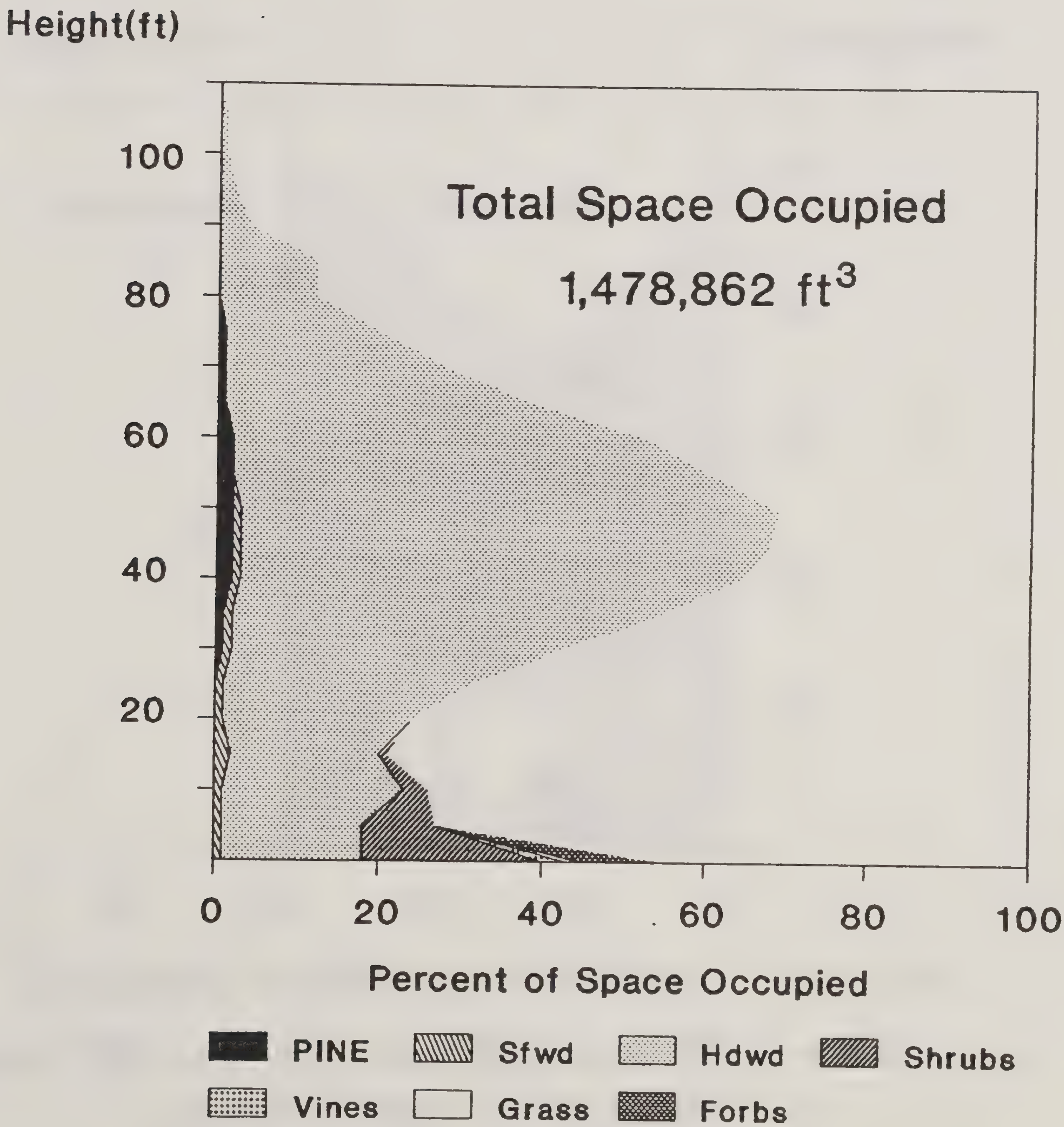


Vegetation Profile
Oak/Hickory 61-70



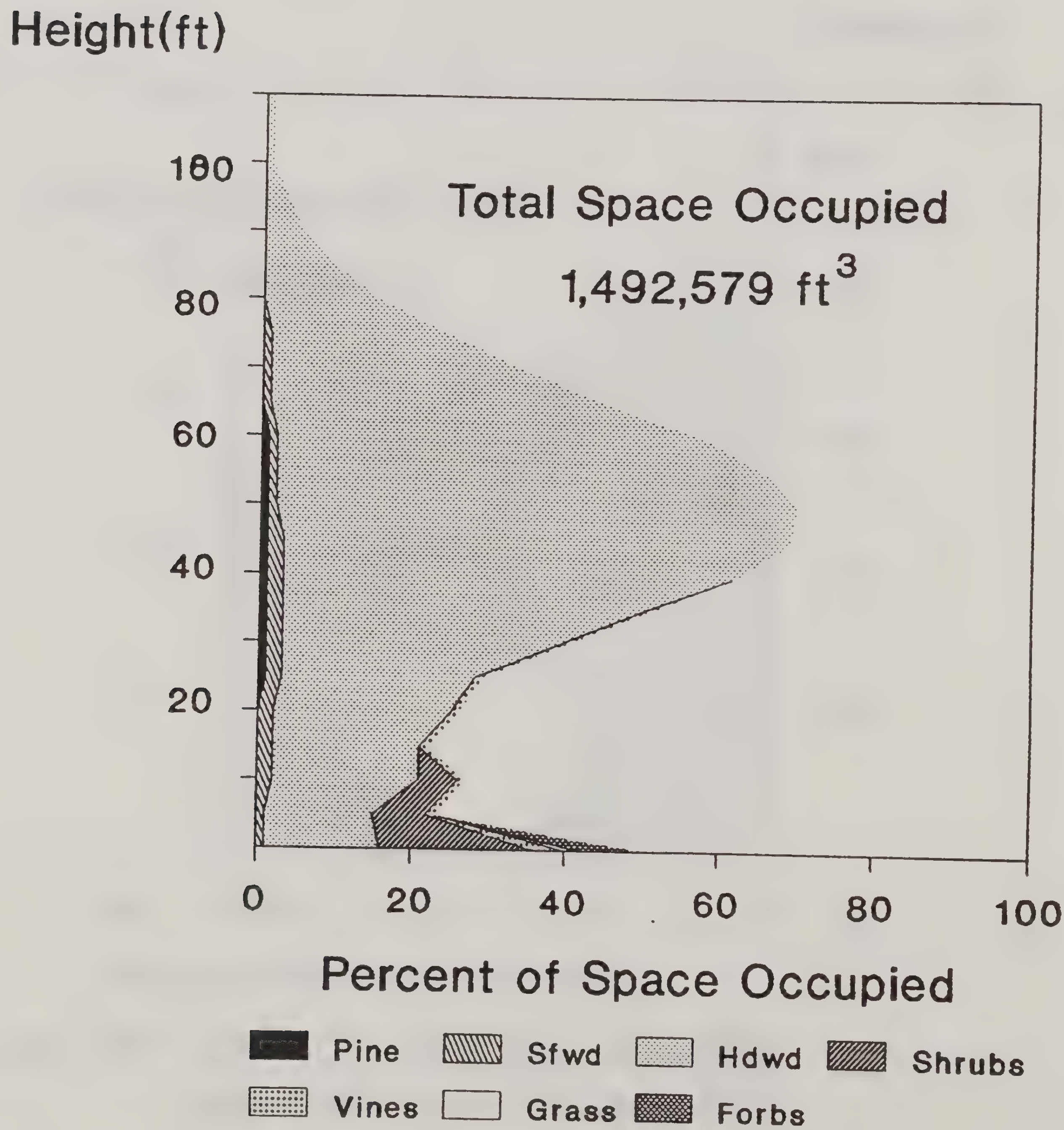
SE/FIA

Vegetation Profile
Oak Hickory 71-80

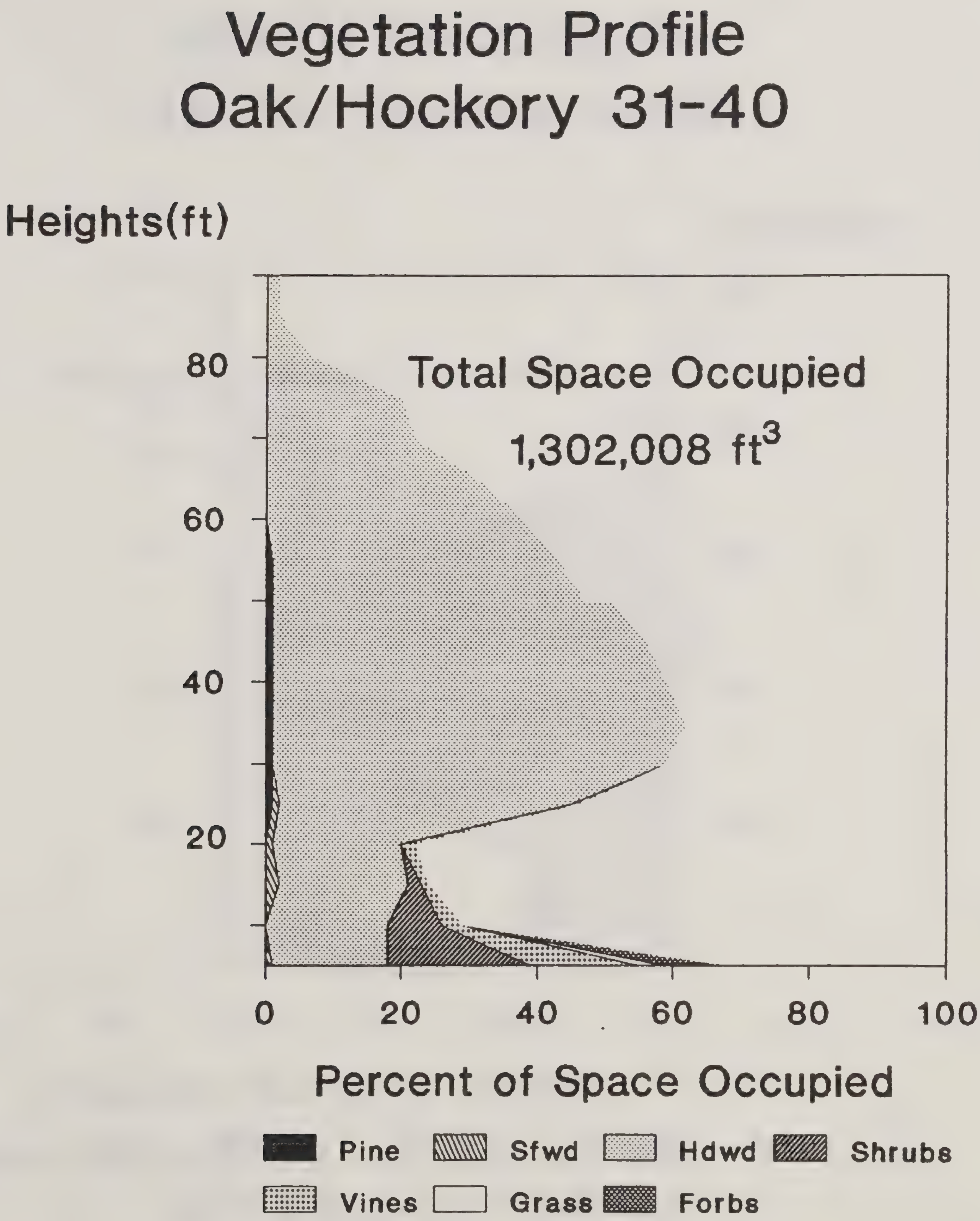


SE/FIA

Vegetation Profile
Oak/Hockory 81+

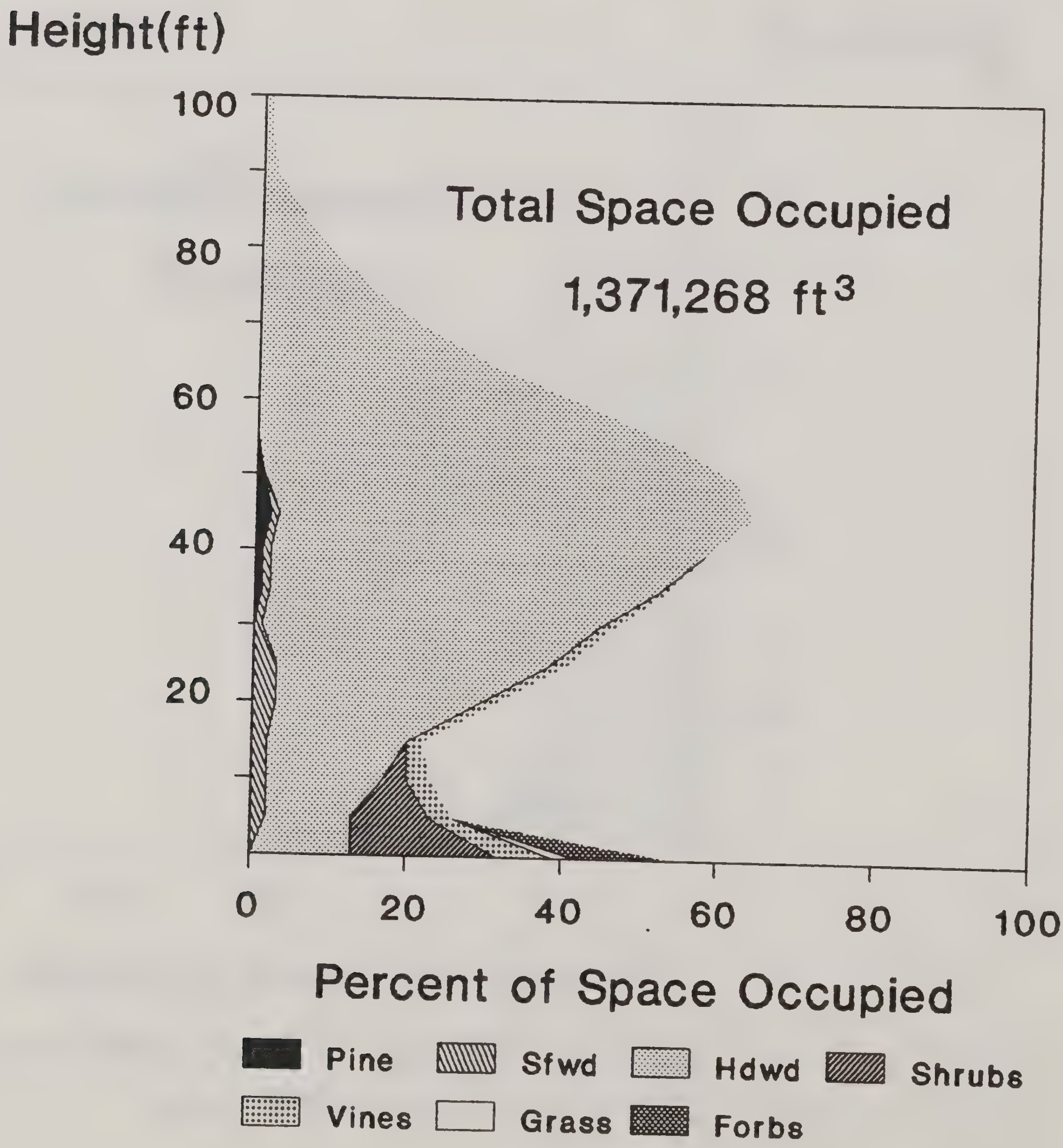


SE/FIA

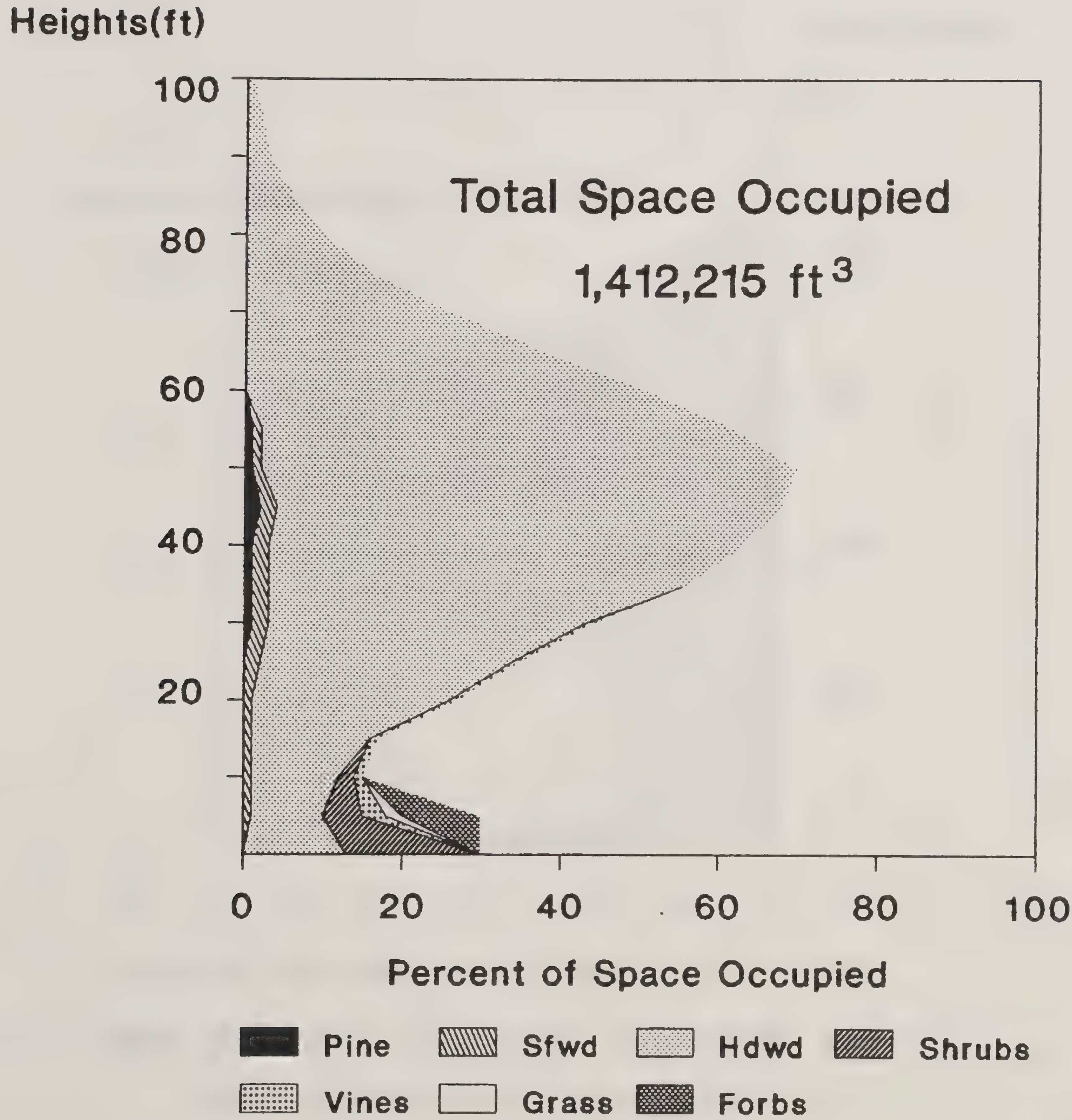

Vegetation Profile
Oak/Hockory 31-40
Heights(ft)
80
60
40
20
Total Space Occupied
1,302,008 ft^3
0
20
40
60
80
100
Percent of Space Occupied
Pine
Sfwd
Hdwd
Shrubs
Vines
Grass
Forbs

SE/FIA

Vegetation Profile
Oak/Hickory 41-50

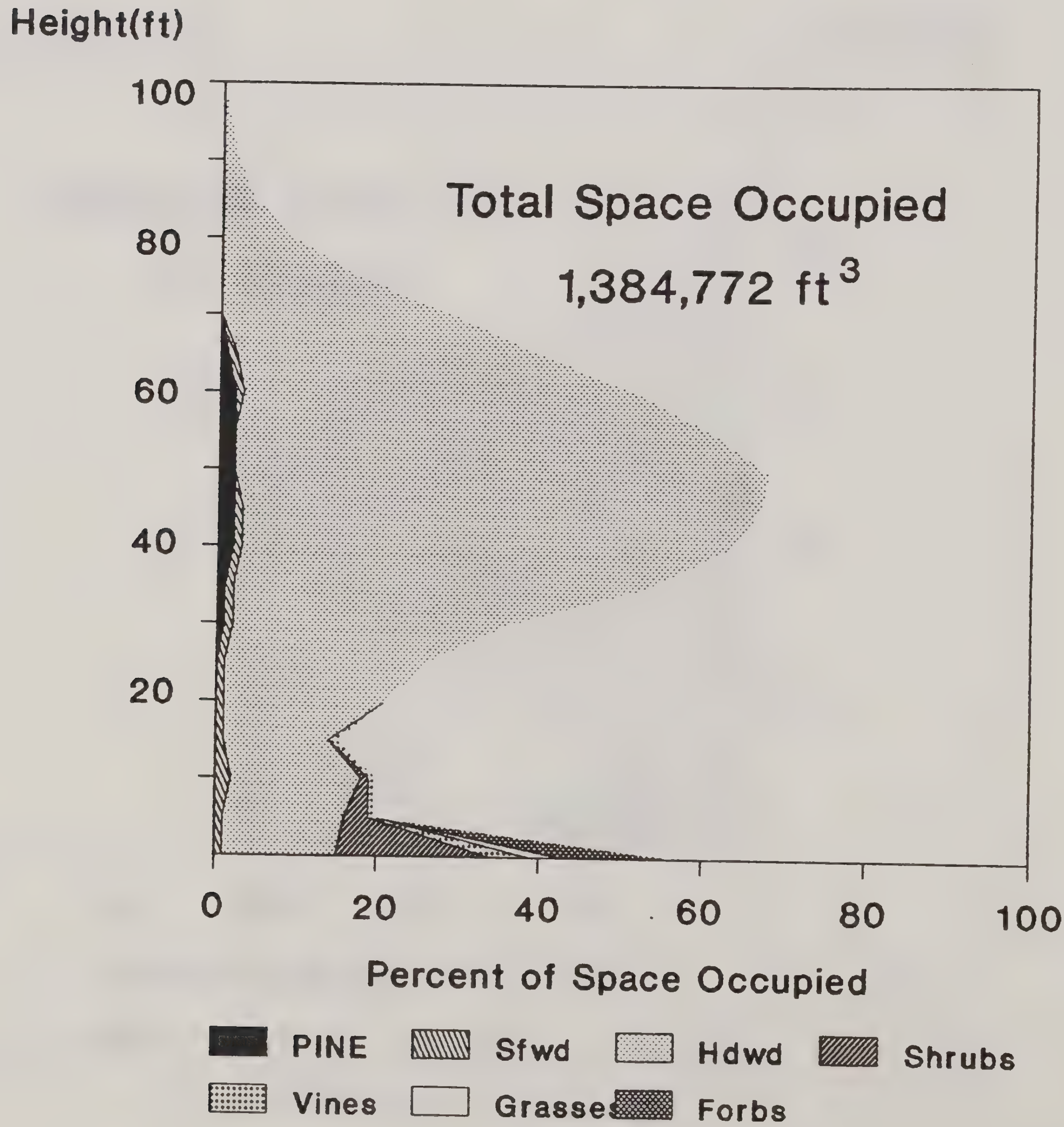


Vegetation Profile
Oak/Hickory 51-60



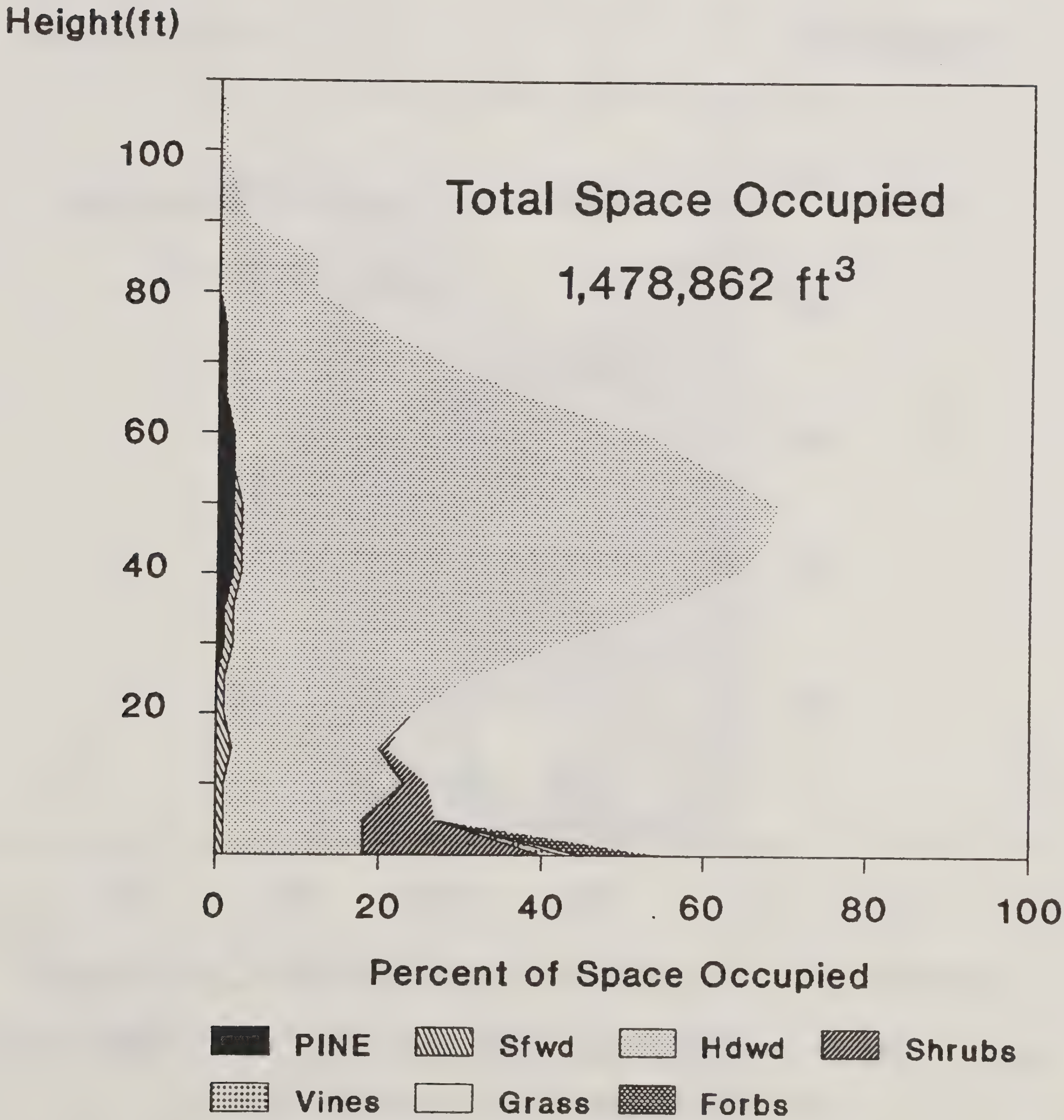
SE/FIA

Vegetation Profile
Oak/Hickory 61-70



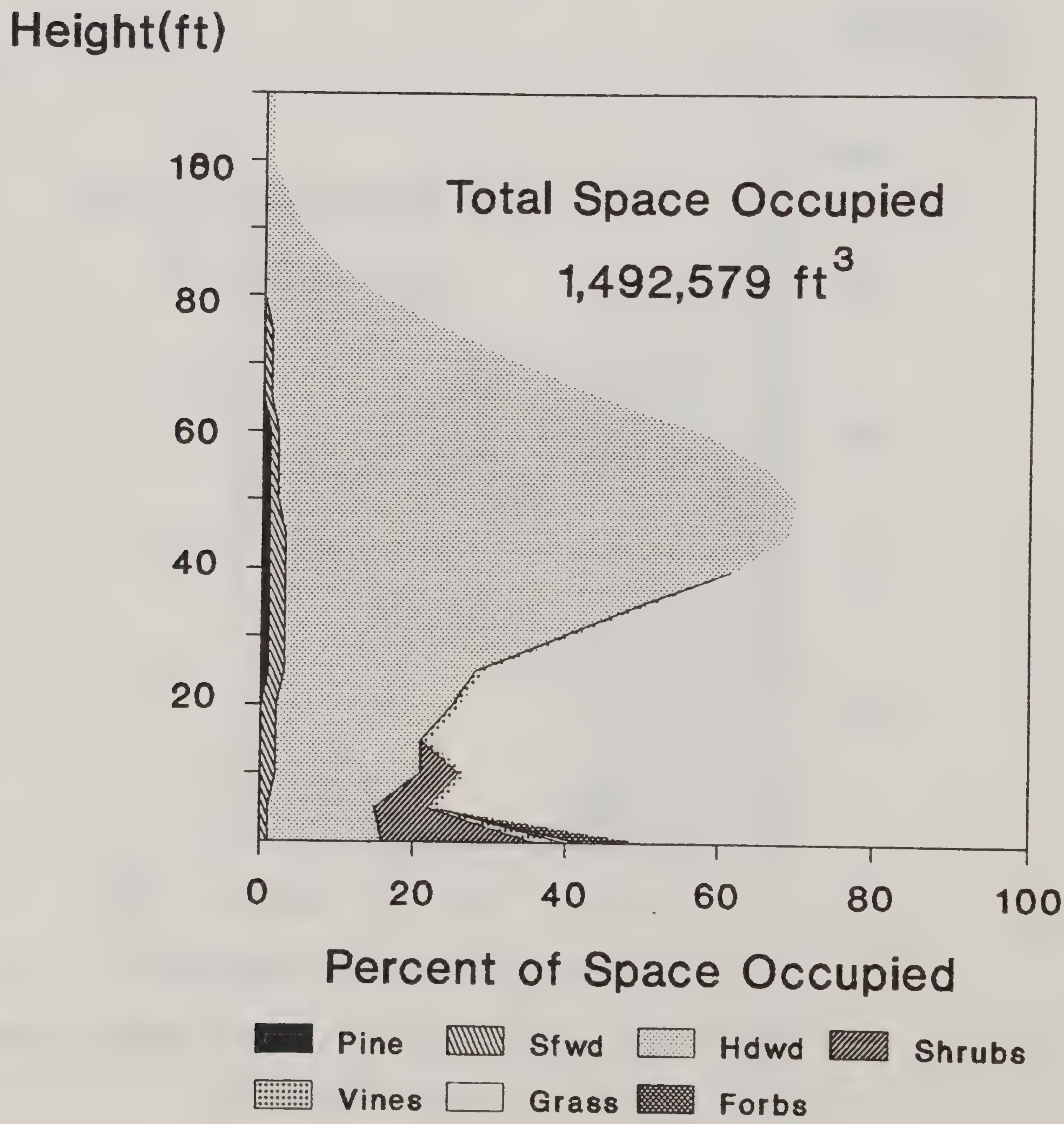
SE/FIA

Vegetation Profile
Oak Hickory 71-80



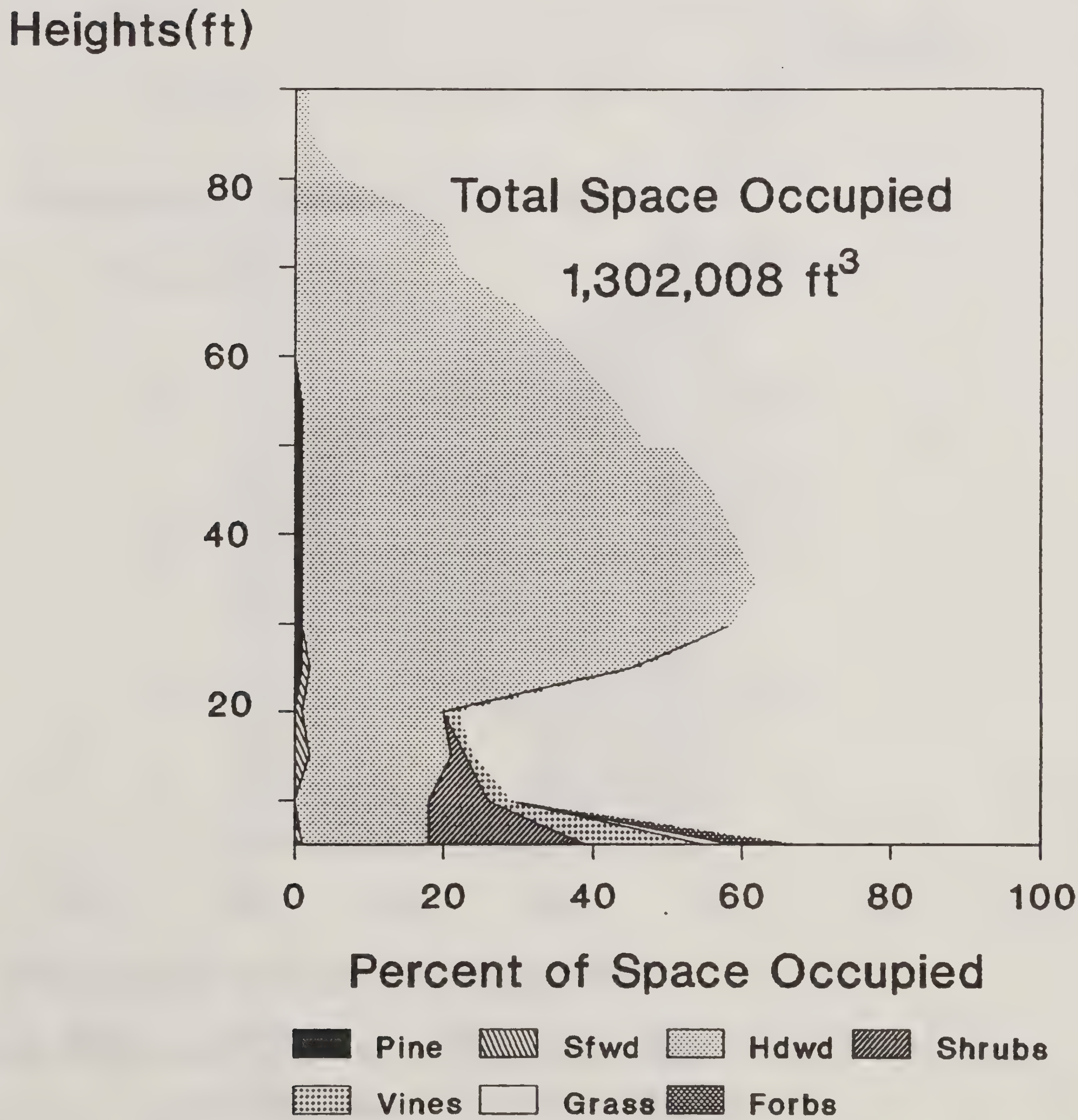
SE/FIA

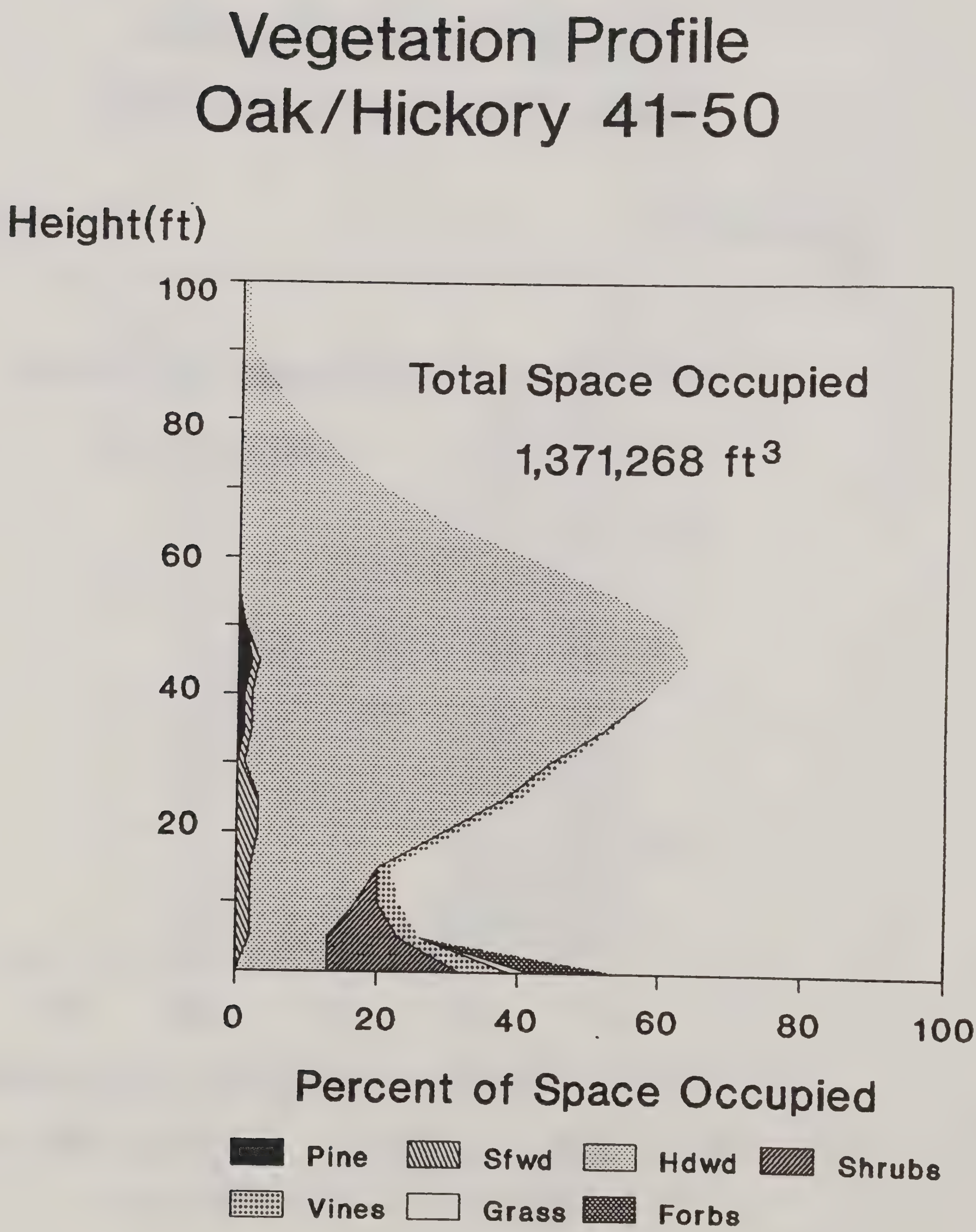
Vegetation Profile
Oak/Hockory 81+



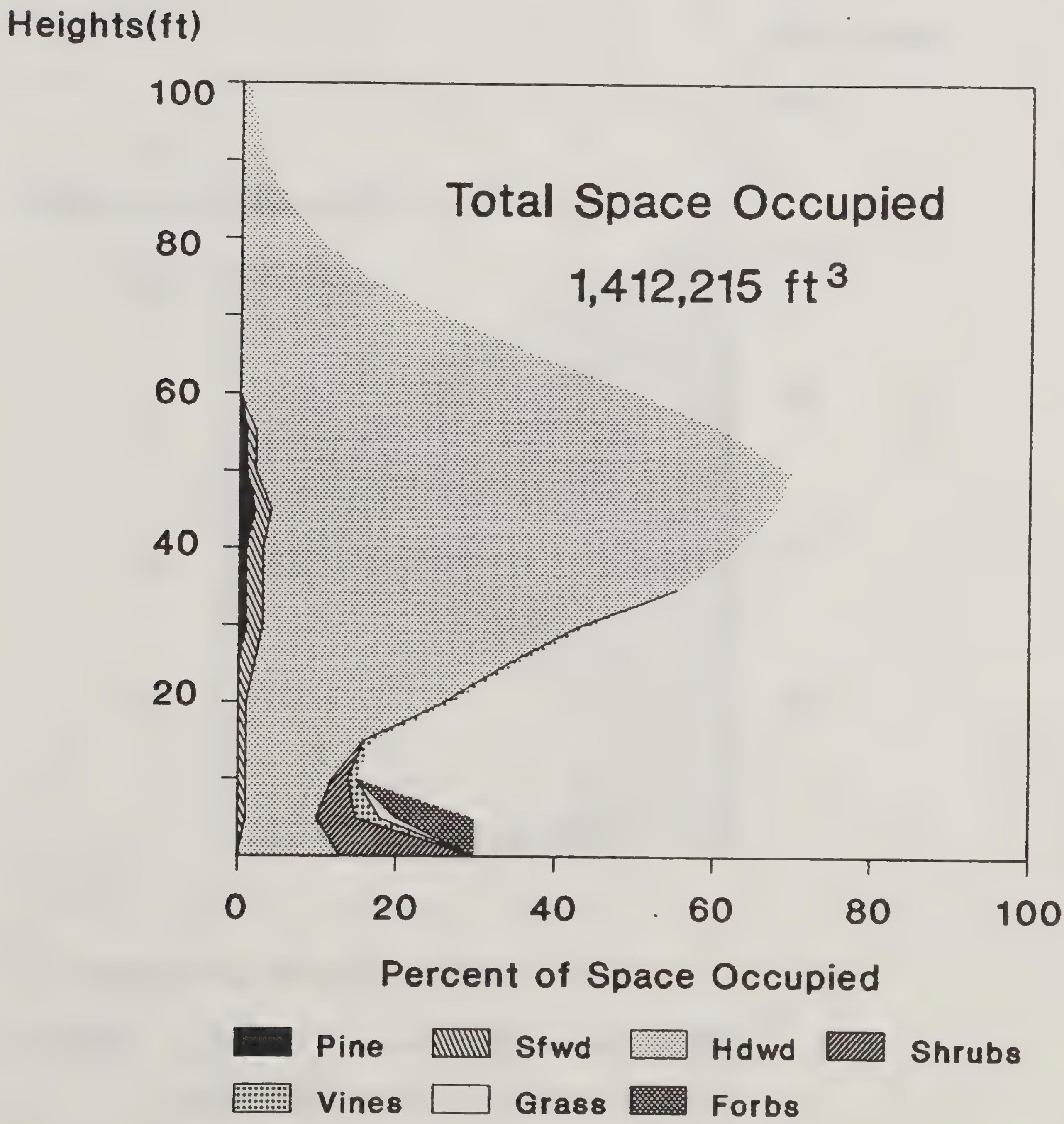
SE/FIA

Vegetation Profile
Oak/Hockory 31-40



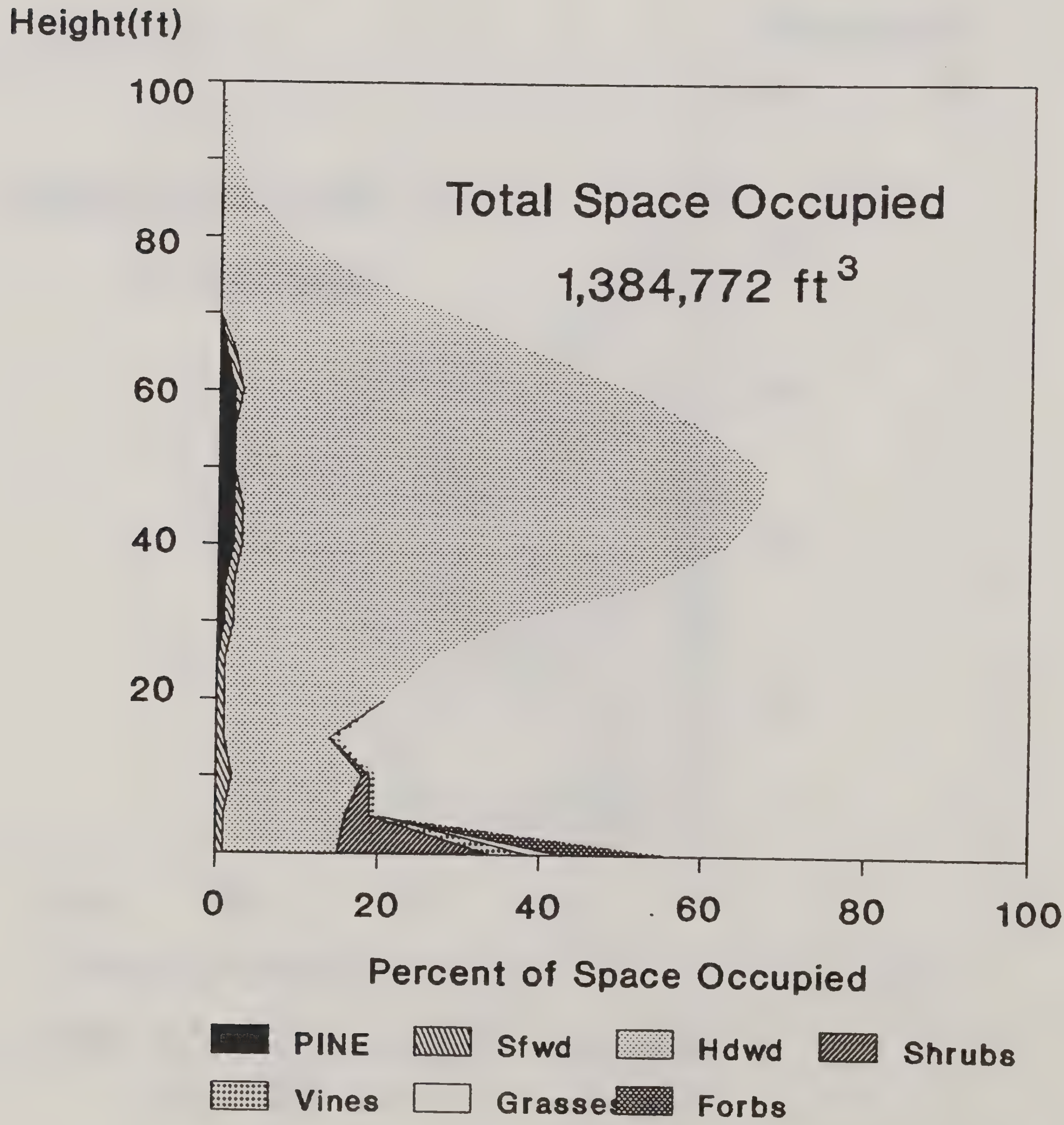

Vegetation Profile
Oak/Hickory 41-50
Height(ft)
100
80
60
40
20
Total Space Occupied
1,371,268 ft3
0
20
40
60
80
100
Percent of Space Occupied
Pine
Sfwd
Hdwd
Shrubs
Vines
Grass
Forbs

Vegetation Profile
Oak/Hickory 51-60



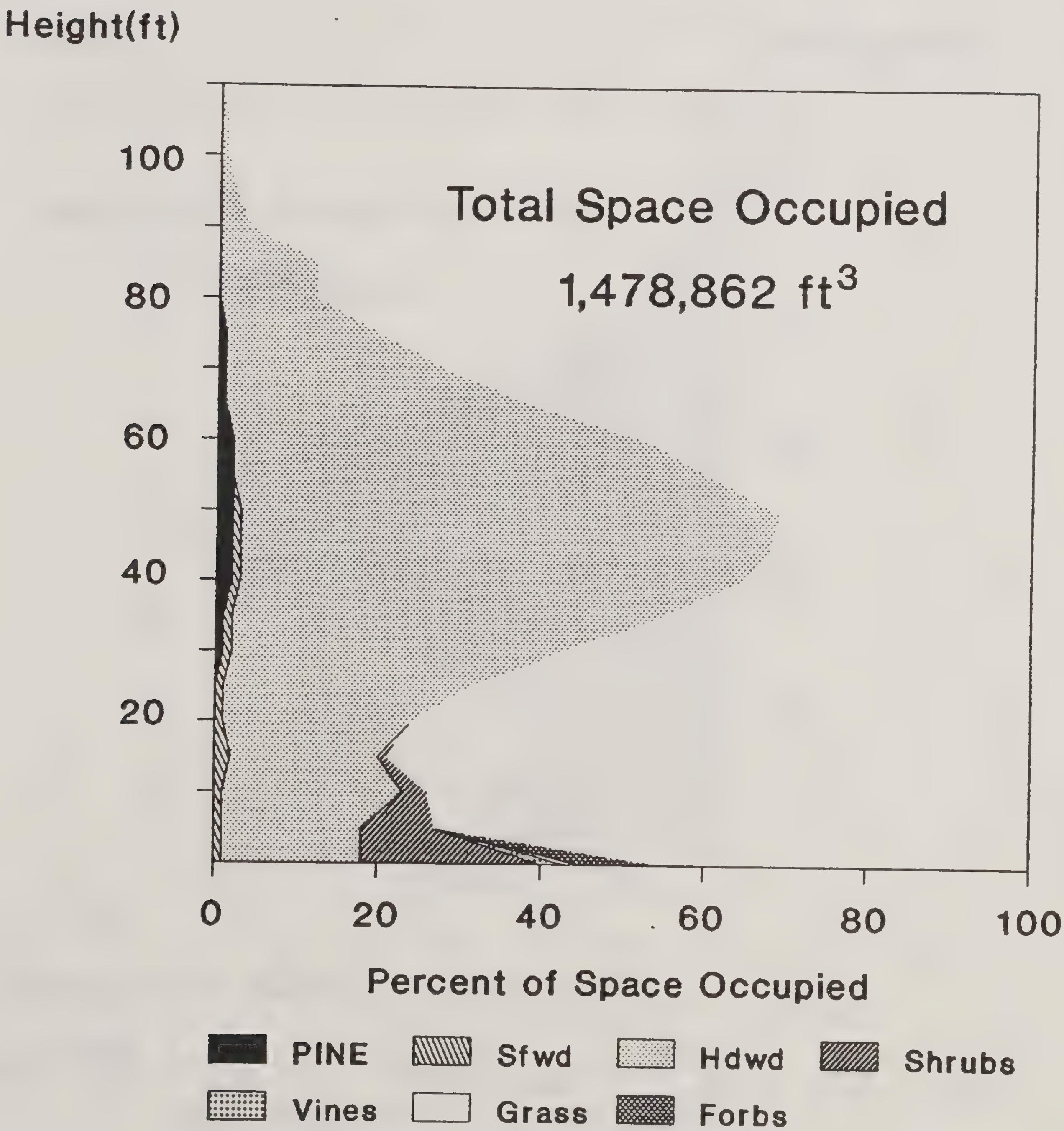
SE/FIA

Vegetation Profile
Oak/Hickory 61-70



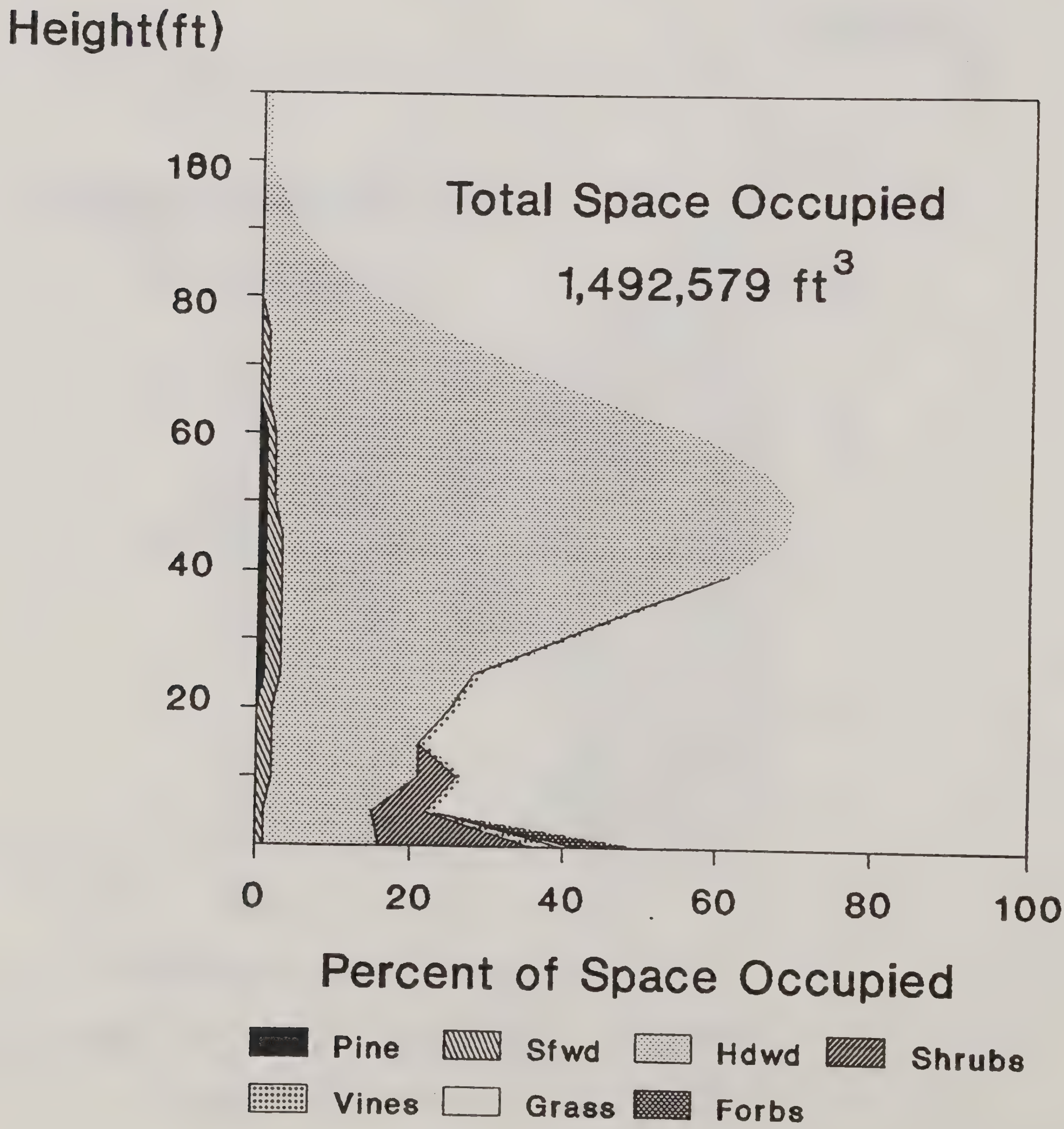
SE/FIA

Vegetation Profile
Oak Hickory 71-80



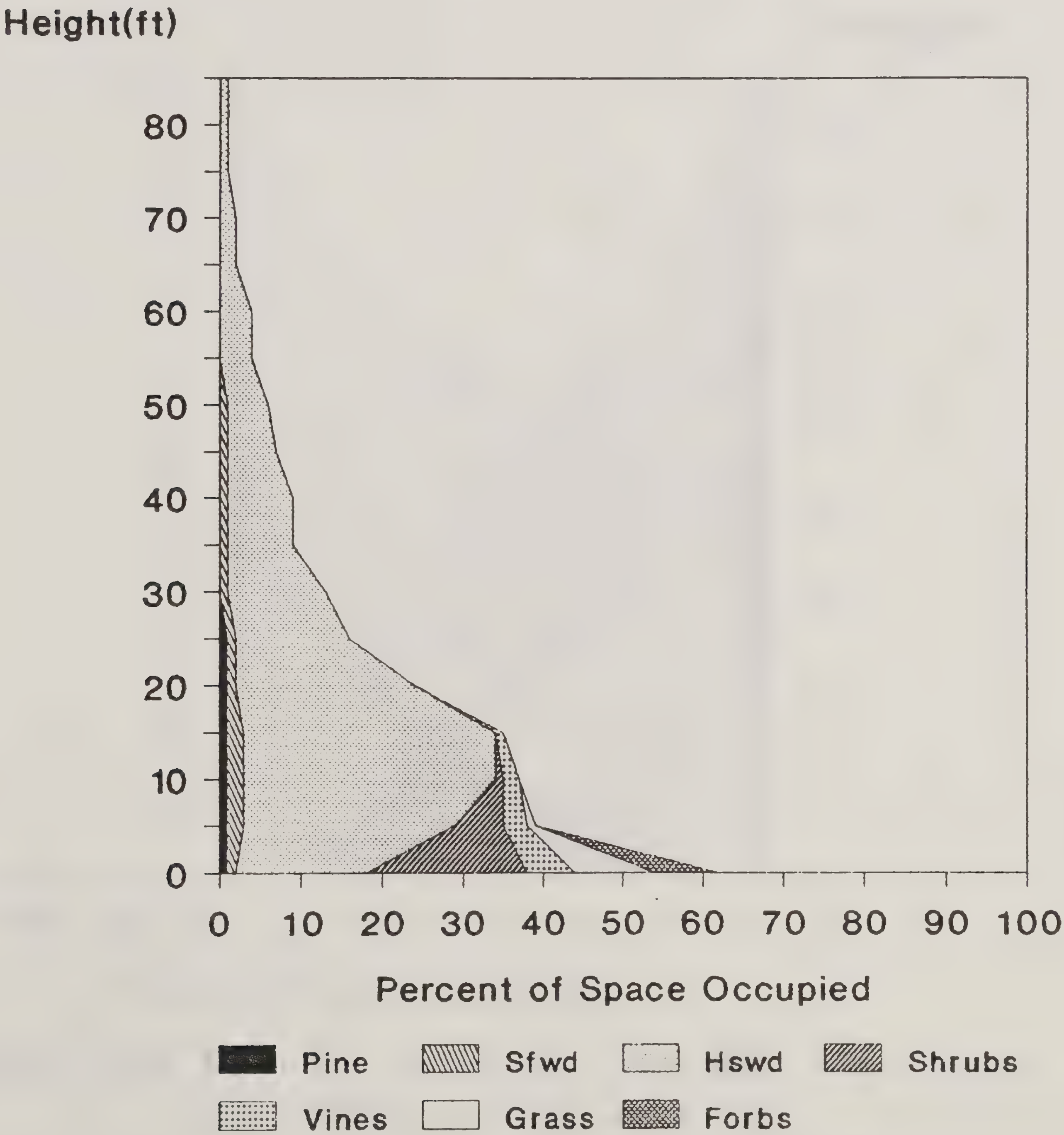
SE/FIA

Vegetation Profile
Oak/Hockory 81+

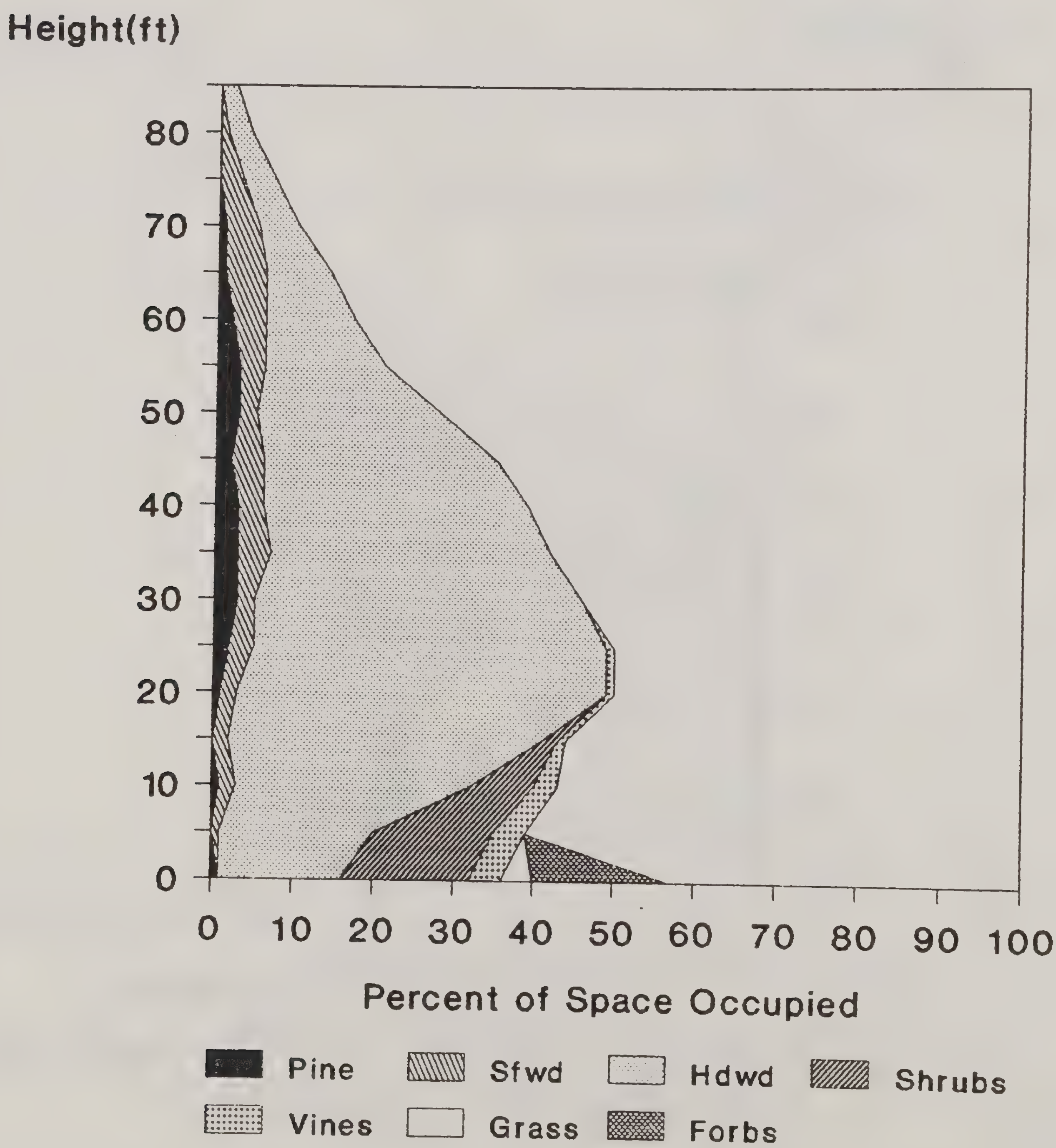


SE/FIA

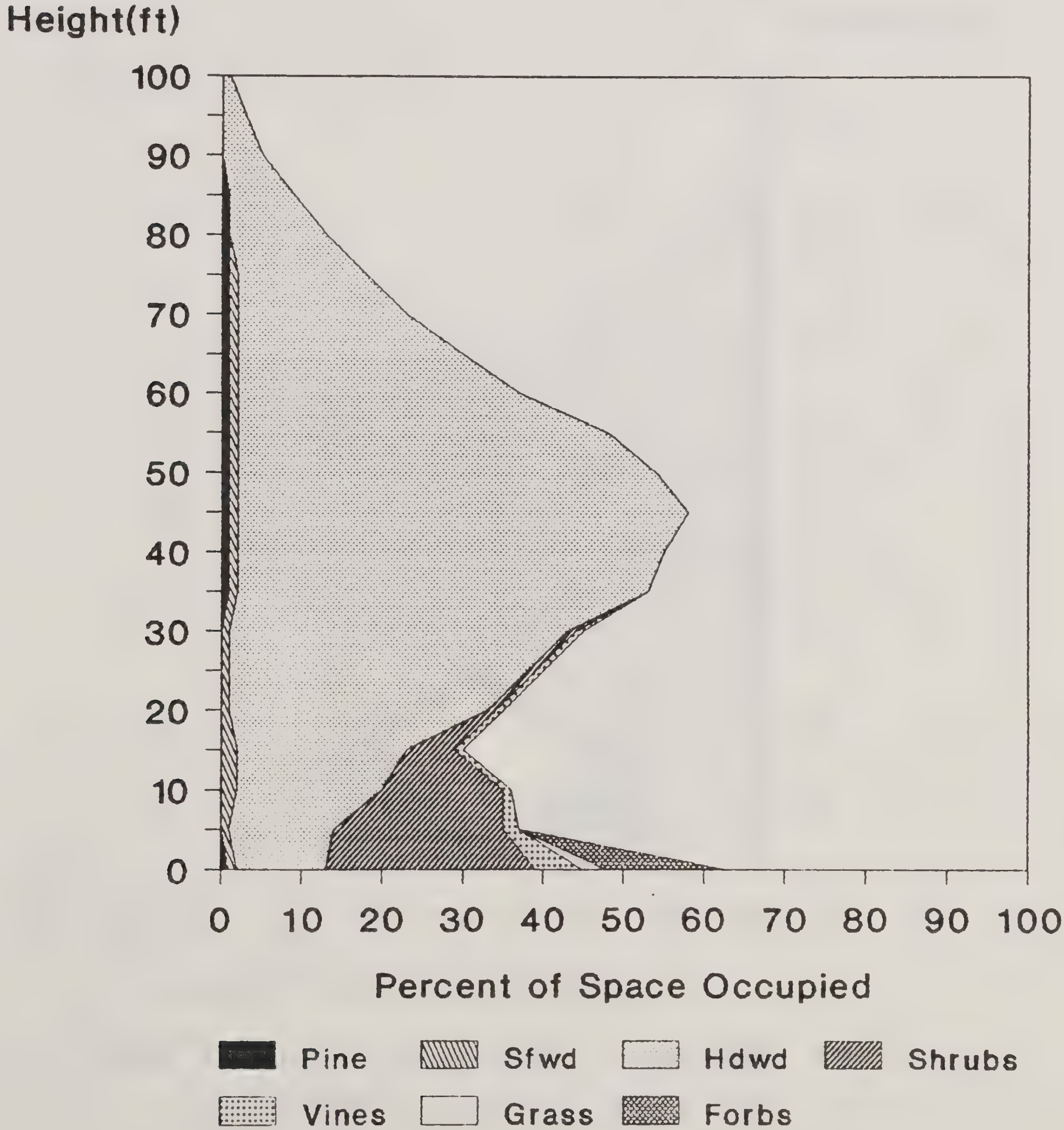
Vegetation Profile for National Forest Hardwood Stands 0-15 Years Old



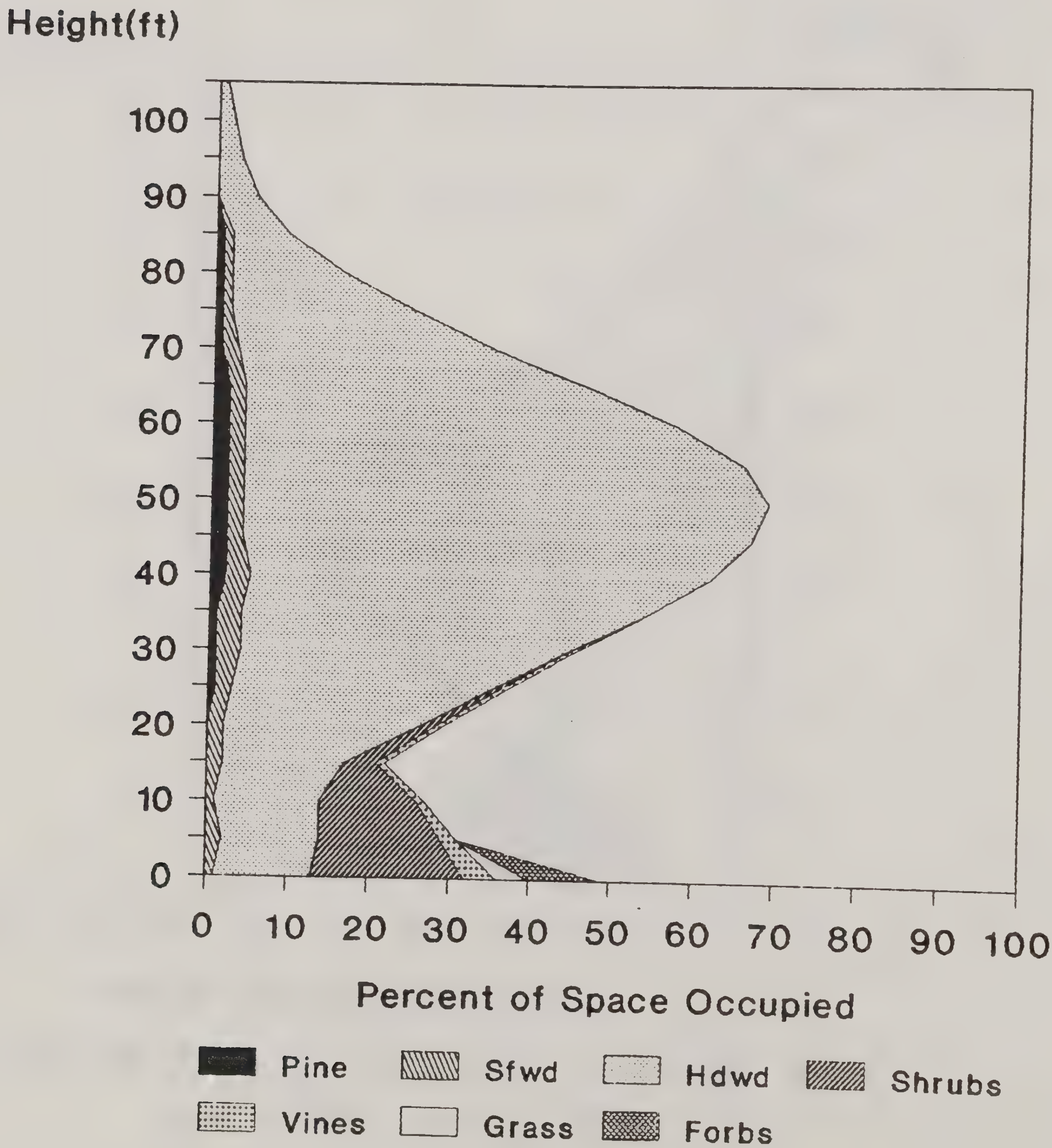
Vegetation Profile for National Forest Hardwood Stands 16-30 Years Old



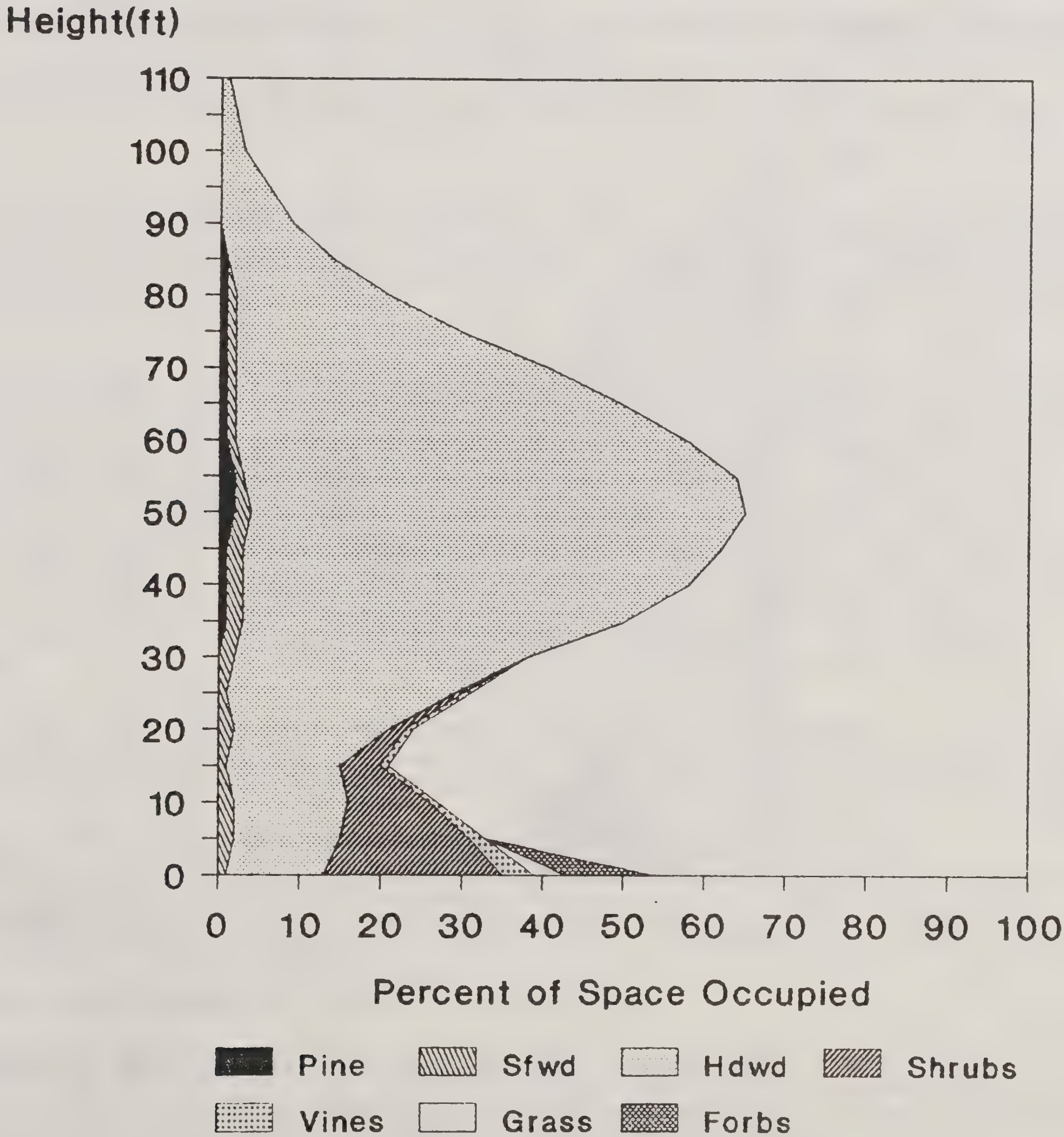
Vegetation Profile for National Forest Hardwood Stands 31-45 Years Old



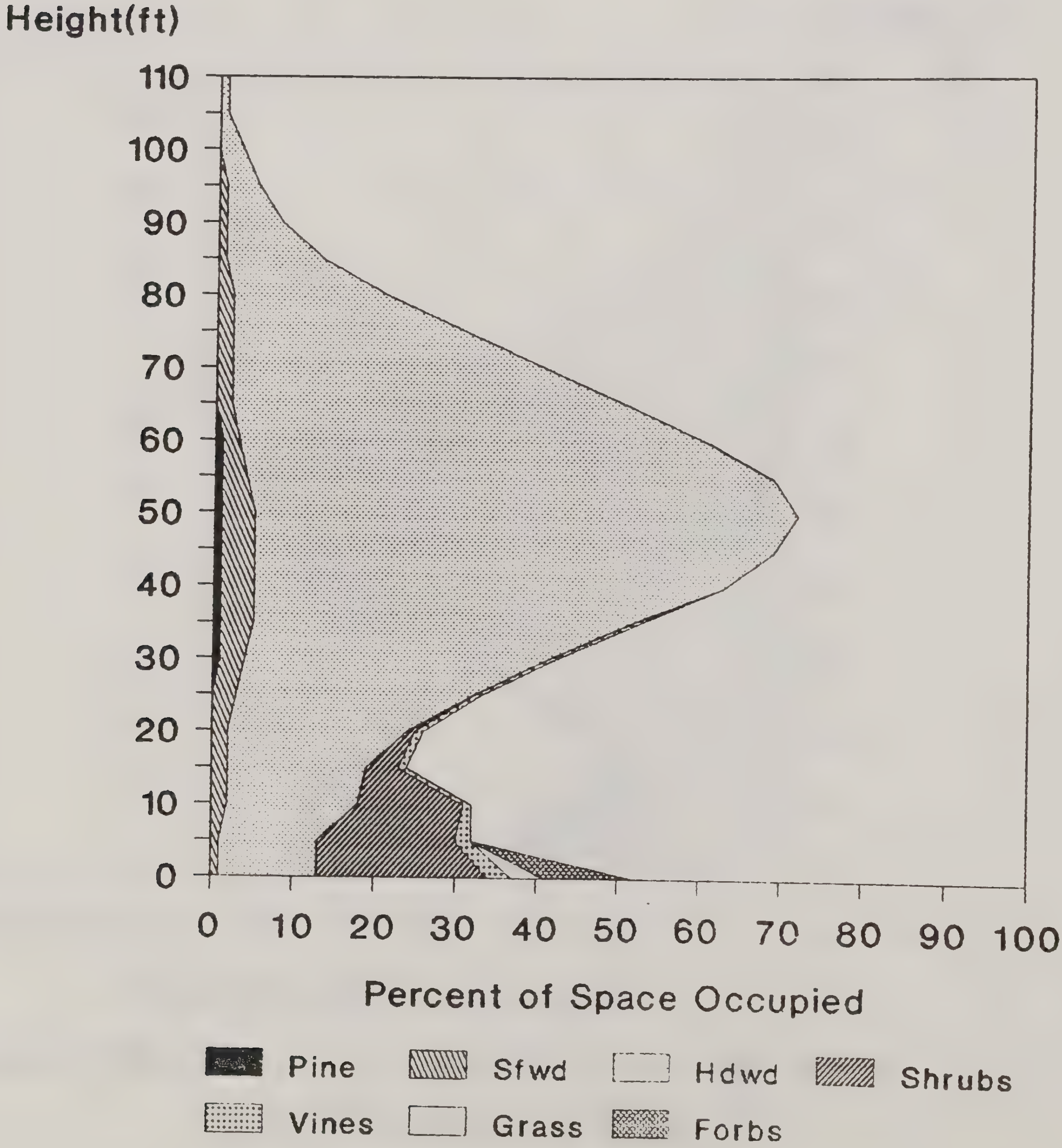
Vegetation Profile for National Forest Hardwood Stands 46-60 Years Old



Vegetation Profile for National Forest Hardwood Stands 61-75 Years Old



Vegetation Profile for National Forest Hardwood Stands 76+ Years Old



LLOYD E. BROWNE
3555 Timberlane Drive
Easton, Pennsylvania 18042

UNCLE LLOYD'S INNOVATION CO.

Phone (215) 250-0946
Fax (215) 250-7078

ATTENTION

MANUFACTURERS, EXPERIMENTERS, AND USERS of *Bacillus thuringiensis* (*B.t.*) INSECTICIDES

UNCLE LLOYD'S INNOVATION COMPANY is now offering an assay service to determine the potency [in International Units per milligram of Sample (IU's) or in Billions of International Units per pound (BIU's)] of your *B.t.* products.

ASSAY PROTOCOLS: The potency of your product is estimated by comparing it's toxicity to cabbage looper with that of a standard *B.t.* product of known potency. Two treatments, your Sample *B.t.* and the Standard *B.t.* are incorporated into BioServ™ Cabbage looper diet on a weight per volume basis. Each treatment is diluted 2:3 in a series of eight dilutions plus an untreated control. Each dilution is tested using fifty, individually caged, 4-day-old cabbage looper larva(*Trichoplusia ni*) per replication. This test is replicated on three different days. Mortality counts are made after four days of feeding on the treated diets. LD_{50} of each treatment replication is estimated using probit analysis.

RELIABILITY: The assay is considered reliable when the calculated LD_{50} lies between the middle six doses tested and the potency estimates of the three replications display a coefficient of variation less than 20%.

SERVICE: The assay requires a minimum of seven days for it's completion. However, for the fastest possible service, we recommend the customer give us a notification seven days prior to sample shipment. When requested, the results will be transmitted by phone or FAX. Raw data is shipped by U S Mail.

COST: $450 per sample

UNCLE LLOYD'S INNOVATION COMPANY is a privately owned laboratory which conducts insect assays and research in insect behavior. The director of research, Lloyd E. Browne, has over 30 years of experience in entomological research including experience in both universities and private industry.

You inquired as to whether on not I plan to use other methods such as chemical measurements to evaluate potency of *Bt* products. I would like to state again that I do not plan to adopt such techniques and I would like to take this opportunity to explain why I feel such tests are not reliable. While I am not an expert in the field of protein or immunochemistry, I did "kibitz" such efforts at Ecogen Inc. for six years. My opinions of these tests are entirely my own and do not necessarily reflect the opinions of Ecogen's management.

The single impediment to the various mono- and poly-cloned antibody/dye linked tests and the band absorption scans of electrophoretic sizing gels was that both tests require the crystal to be dissolved prior to testing. Once dissolved the toxin is very vulnerable to destruction by proteinases present in the "soup". The various fermentation media used by producers is often selected on a cost basis and differs considerably from the chemically defined media usually used in research production. Commercial media vary greatly in their proteinase content. On some media the proteinase level is so high that the toxin is "chewed up" almost as fast as it is dissolved. Apparently, isolating and washing the toxin crystal does not alleviate this problem as the proteinases can be entrained in the crystal. Perhaps a producer who has standardized their production and calibrated their test procedures with bioassay can use these chemical tests. But for someone, such as myself, who would be testing many different products of unknown compositions, such tests would not be useful.

I thank you again for your interest in Uncle Lloyd's.

Sincerely,

Lloyd E. Browne

Lloyd E. Browne

sheal.let

LLOYD E. BROWNE
3555 Timberlane Drive
Easton, Pennsylvania 18042

Phone (215) 250-0946
Fax (215) 250-7078

June 24, 1991

Dr. Patrick Shea
Principal Research Entomologist
USDA Forest Service, Suit 102
2121 C, Second Street
Davis, CA 95616

Dear Dr. Shea:

Thank you for your inquiry into the *Bacillus thuringiensis* (Bt) potency assay service that I offer here at the Uncle Lloyd's Company. To my knowledge the Uncle Lloyd's Co. is the only laboratory in the United States offering to contract such service. The assay service is outlined on the enclosed information sheet. The procedures I use follow those agreed upon by a group of industry and USDA personnel at a meeting in Brownsville TX, September 22, 1982 (Preliminary Report on Standardization of Lepidopterous *Bacillus thruingiensis* Bioassays). Most of the larger Bt producing companies use these procedures to adjust the potency of their product as this is the accepted procedure for determining potency in Billions of International Units per unit of Product (BIU's). BIU's are arbitrary units of toxicity assigned to a single standard preparation of Bt (HD-1 1980-S). The assay compares the ratio of *Trichoplusia ni* larva killed per unit weight (LD_{50}) by the sample to those killed by the standard. This assay is reliable so long as the assay insects are healthy, the assay protocols are rigorously followed, and only HD-1 strains are compared.

Presently, the health of my *T. ni* colony is outstanding. Two problems constantly plague laboratory colonies of *T. ni*. One; a black mold occurs when the humidity is not controlled. Two; most *T. ni* colonies have a rickettsia present that may show itself under crowded or otherwise stressful conditions. I have implemented procedures that appear to have alleviate the pathogenicity of both agents (at least for now). In regard to the assay procedures, I have obtained the minutes to the Brownsville meeting and I try to follow these as close as possible. However, I do not know how closely the Bt producers are following them but of the products I have tested thus far I get good agreement with the label claims. These assay protocols, while good, probably can be improved, at least from a statistical standpoint, and I am working to do just that. Strains other than HD-1 can be evaluated by assay but to do so would require establishing some agreed-upon standard preparation for the strain tested. If the Forest Service wishes to work with other strains of Bt then I would request standards from the manufacturer.

Win McLane
September 1991

A Report to the National Steering Committee for Aerial Application of Pesticides Gypsy Moth and Other Eastern Defoliators

Win McLane

USDA, APHIS, S&T
Otis Methods Development Center
Building 1398
Otis ANGB, MA 02542
508-563-9303

Laboratory testing was conducted with registered gypsy moth spray materials and a number of experimental compounds. All bioassay work was done using a standard red oak seedling technique with newly moulted, laboratory reared, 2nd instar gypsy moth larvae as test insects.

Table 1. Percent larvae mortality and seedling defoliation following exposure to oak treated with laboratory and field samples of Dipel 8L and ABG 7022, Dipel Tech. powder and ABG 7022, Dipel 8AF and ABG 7022 and Foray 48B.

Sample	BIU Acre	Percent Mortality			Percent Defoliation		
		4 day	6 day	8 day	4 day	6 day	8 day
8AF + ABG 7022 Lab	10/40 oz	6	23	80	4	8	15
8AF + ABG 7022 Lab	20/80 oz	25	66	94	3	6	7
Foray 48B Lab	10/40 oz	18	53	85	4	13	18
Foray 48B Lab	20/80 oz	38	77	97	3	3	4
8L + ABG 7022 Lab	10/40 oz	33	58	82	3	9	12
8L + ABG 7022 Lab	20/80 oz	60	94	100	1	2	2
8L + ABG 7022 Field	10/40 oz	44	90	99	3	3	3
8L + ABG 7022 Field	20/40 oz	52	78	94	3	6	8
T. Powder + ABG 7022 Field	10/40 oz	64	92	100	1	2	3
T. Powder + ABG 7022 Field	20/80 oz	82	96	100	2	2	2
Control	0	0	0	0	74	86	

There has always been a question as to how much outside drying time is needed before rainfall. Often spraying will continue until six hours before expected rainfall. Some will say the spray only needs 1 - 3 hours in sunlight to dry and make it resistant to rainfall. Others will say wash-off is no problem when the Bt formulation is applied undiluted.

At the Otis Methods Development Center large numbers of northern red oak seedlings were sprayed with Dipel 8AF and Dipel 8L and held outdoors for various periods of time in the direct sunlight. Following various exposure times, seedlings were returned to the laboratory and exposed to various amounts of rainfall. A bioassay was then conducted to determine efficacy and, therefore, wash-off. The spray material was applied in a laboratory spray chamber using 20 BIU/gal/acre and 20 BIU/40 oz/acre (neat). Newly moulted 2nd instar, laboratory reared, gypsy moth larvae were used as test insects. Rain was applied to seedlings with Delvon rain-drop nozzles.

Table 2. Percent larvae mortality following a four and eight day exposure to oak seedlings treated with Dipel 8AF at 20 BIU/gal/a, exposed to direct outside sunlight, exposed to rainfall with bioassay following.

Hours Outside	Hours Inside	Percent Mortality No Rain[1/]	.10"	.25"	.50"	1.0"
	6	86 (100)	14 (79)	48 (97)	61 (93)	6 (50)
1		91 (99)	61 (96)	75 (93)	44 (88)	11 (58)
2		87 (100)	66 (92)	73 (97)	73 (95)	10 (66)
3		92 (100)	37 (89)	76 (100)	47 (86)	5 (44)
4		92 (100)	73 (99)	78 (100)	71 (94)	9 (60)
5		89 (100)	53 (98)	93 (100)	61 (91)	11 (54)
6		84 (100)	58 (97)	71 (100)	52 (78)	3 (39)
Control 6		0 (0)	0 (1)	0 (1)	0 (1)	0 (0)
	Control 6	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)

[1/]Average of 4 tests
( ) 8 day reading

Table 3. Percent seedling defoliation in test presented in Table 2.

Hours Outside	Hours Inside	Percent Defoliation No Rain[1/]	.10"	.25"	.50"	1.0"
	6	10 (11)	54 (67)	34 (49)	40 (47)	78 (78)
1		6 (6)	13 (15)	11 (31)	42 (58)	68 (74)
2		8 (8)	20 (38)	13 (19)	28 (31)	66 (66)
3		8 (9)	23 (36)	20 (20)	37 (43)	72 (72)
4		10 (10)	16 (26)	9 (22)	22 (22)	68 (71)
5		9 (10)	13 (19)	10 (10)	36 (36)	66 (74)
6		13 (13)	26 (32)	34 (34)	48 (62)	78 (78)
Control 6		94 (94)	100 (100)	99 (100)	95 (100)	90 (100)
	Control 6	95 (100)	100 (100)	100 (100)	98 (100)	98 (100)

[1/]Average of 4 tests
( ) 8 day reading

Table 4. Percent larvae mortality and seedling defoliation following a four and six day exposure to oak seedlings teated with Dipel 8AF at 20 BIU/40 oz/a (Neat), exposed to direct outside sunlight, exposed to rainfall with bioassay following.

Hours Outside	Hours Inside	Percent Mortality No Rain[1/]	Percent Mortality .25"	Percent Defoliation No Rain	Percent Defoliation .25"
	6	98 (100)	77 (99)	3	25
1		99 (100)	93 (100)	4	20
2		100 (100)	98 (100)	5	23
3		99 (100)	82 (98)	3	27
4		98 (100)	54 (95)	4	26
5		100 (100)	82 (99)	3	19
6		99 (100)	79 (99)	3	15
Control 6		0 (1)	5 (17)	78	80
	Control 6	0 (3)	0 (0)	78	100

[1/]Average of 4 tests
( ) 6 day reading

Table 5. Percent larvae mortality following a four and eight day exposure to oak seedlings treated with Dipel 8L at 20 BIU/gal/a, exposed to direct outside sunlight, exposed to rainfall with bioassay following.

Hours Outside	Hours Inside	Percent Mortality No Rain[1/]	.10"	.25"	.50"	1.0"
	6	53 (92)	12 (32)	2 (19)	2 (5)	0 (2)
1		63 (94)	50 (93)	2 (39)	0 (12)	5 (29)
2		67 (96)	52 (82)	9 (33)	3 (15)	3 (54)
3		66 (95)	54 (85)	47 (96)	2 (33)	14 (47)
4		63 (94)	23 (73)	26 (83)	1 (26)	16 (68)
5		50 (88)	36 (95)	39 (76)	5 (74)	15 (40)
6		44 (88)	31 (87)	10 (24)	9 (35)	11 (50)
Control 6		0 (0)	0 (0)	1 (2)	0 (2)	0 (0)
	Control 6	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)

[1/]Average of 4 tests
( ) 8 day reading

Table 6. Percent seedling defoliation in test presented in Table 5.

Hours Outside	Hours Inside	Percent Defoliation No Rain[1/]	.10"	.25"	.50"	1.0"
	6	26 (34)	25 ( )	94 (96)	96 (96)	92 (92)
1		18 (24)	34 (34)	81 (86)	88 (94)	87 (90)
2		20 (26)	29 (30)	77 (78)	97 (97)	81 (81)
3		16 (20)	24 (24)	32 (42)	90 (96)	49 (54)
4		18 (20)	32 (39)	41 (64)	83 (85)	49 (56)
5		28 (39)	32 (38)	39 (57)	60 (76)	72 (72)
6		32 (45)	29 (42)	85 (87)	76 (79)	69 (72)
Control 6		80 (80)	66 (66)	100 (100)	98 (98)	98 (82)
	Control 6	80 (80)	85 (85)	90 (90)	90 (100)	100 (100)

[1/]Average of 4 tests
( ) 8 day reading

Table 7. Percent larvae mortality and seedling defoliation following a four and eight day exposure to oak seedlings treated with Dipel 8L at 20 BIU/40 oz/a (Neat), exposed to direct outside sunlight, exposed to rainfall with bioassay following.

Hours Outside	Hours Inside	Percent Mortality		Percent Defoliation	
		No Rain[1/]	.25"	No Rain	.25"
	6	91 (100)	3 (9)	6 (6)	81 (81)
1		79 (98)	14 (44)	16 (18)	62 (83)
2		67 (93)	26 (69)	15 (26)	48 (60)
3		68 (97)	10 (78)	19 (23)	69 (71)
4		74 (97)	25 (75)	16 (25)	34 (57)
5		81 (98)	35 (81)	10 (10)	37 (52)
6		75 (99)	35 (85)	11 (13)	72 (73)
Control 6		0 (0)	0 (0)	96 (100)	92 (100)
	Control 6	0 (0)	0 (0)	94 (100)	96 (100)

[1/]Average of 4 tests
( ) 8 day reading

Similar weathering tests were conducted with Foray 48B.

Table 8. Percent larvae mortality 4 days after exposure to oak seedlings treated with Foray 48B at 20 BIU/gal/acre, dried outdoors in direct sunlight and then exposed to rainfall with bioassay following.

Hours Outside	Hours Inside	Percent Mortality				
		No Rain	.10"	.25"	.50"	1.0"
	6	93[1/]	30	6	33	28
1		99	83	52	20	46
2		98	57	40	26	37
3		98	78	31	38	34
4		94	89	39	39	43
5		95	65	5	67	63
6		90	75	14	59	46
Control 6		0	0	0	0	0
	Control 6	0	0	0	0	0

[1/]Average of 4 tests

Table 9. Percent defoliation of oak seedlings in tests presented in Table 8.

Hours Outside	Hours Inside	Percent Defoliation				
		No Rain	.10"	.25"	.50"	1.0"
	6	3[1]	14	54	61	53
1		2	10	22	71	52
2		2	12	17	49	44
3		3	16	28	50	26
4		3	3	20	58	50
5		4	4	39	29	30
6		4	8	34	27	36
Control 6		98	82	100	100	98
	Control 6	89	100	100	100	100

[1]Average of 4 tests

Table 10. Percent larvae mortality 8 days after exposure to oak seedlings treated with Foray 48B at 20 BIU/gal/acre, dried outdoors in direct sunlight and then exposed to rainfall with bioassay following (same test as Table 8 - only 8 day reading).

Hours Outside	Hours Inside	Percent Mortality				
		No Rain	.10"	.25"	.50"	1.0"
	6	100[1]	86	61	80	81
1		100	100	93	77	68
2		100	100	98	75	81
3		100	98	76	95	83
4		100	99	95	69	83
5		100	100	82	99	98
6		100	99	86	98	98
Control 6		0	1	0	2	1
	Control 6	1	0	0	0	0

[1]Average of 4 tests

Table 11. Percent larvae mortality and seedling defoliation 4 days after exposure to oak seedlings treated with Foray 48B at 20 BIU/53 oz./acre (neat), dried outdoors in direct sunlight and then exposed to rainfall with bioassay following).

Hours Outside	Hours Inside	Percent Mortality		Percent Defoliation	
		No Rain	.25"	No Rain	.25"
	6	97	2	5	75
1		100	33	3	58
2		98	42	4	46
3		99	53	4	52
4		98	23	5	60
5		97	45	6	48
6		94	24	12	48
Control 6		0	0	79	84
	Control 6	0	0	98	100

Table 12. Percent larvae mortality 8 days after exposure to oak seedlings treated with Foray 48B at 20 BIU/53 oz./acre (neat), dried outdoors in direct sunlight and then exposed to rainfall with bioassay following (same test as Table 11 only 8 day rearing).

Hours	Hours	Percent Mortality	
Outside	Inside	No Rain	.25"
	6	100	16
1		100	70
2		100	76
3		100	91
4		100	76
5		100	90
6		100	71
Control 6			
	Control 6		

A series of tests were conducted with Foray 75 BFC.

Table 13. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with Foray 75BFC and Foray 48B at various dosages.

Formulation	BIU/Gal 128 oz/acre	Percent Mortality 2 day	4 day	6 day	Percent Defoliation 2 day	4 day	6 day
Foray 75 BFC	24	78	99	100	3	4	4
	20	68	98	100	3	6	6
	16	61	95	100	4	4	4
	8	25	57	93	8	27	27
	4	24	32	91	14	23	25
Foray 48 B	24	87	99	100	2	2	2
	20	83	100		2	3	
	16	90	100		1	1	
	8	63	99	100	3	4	4
	4	44	90	99	9	11	12
Control	--	0	0	0	60	88	100

Table 14. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with *Bacillus thuringiensis* at various dosages using undiluted (neat) applications.

Foray Formulation	BIU Acre	Percent Mortality 2 day	Percent Mortality 4 day	Percent Mortality 6 day	Percent Defoliation 2 day	Percent Defoliation 4 day	Percent Defoliation 6 day
75 BFC	4	48	92	98	7	9	9
75 BFC	8	67	99	100	3	3	3
75 BFC	16	72	97	100	2	2	2
75 BFC	20	96	100		1	1	
75 BFC	24	81	100		3	3	
48 B	4	78	98	100	2	2	2
48 B	8	54	98	100	5	5	5
48 B	16	83	99	100	3	3	3
48 B	20	91	100		1	1	
48 B	24	93	100		1	1	
Control	--	0	0	0	88		

Table 15. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with *Bacillus thuringiensis* at 20 BIU/gal/a and exposed to rainfall.

Foray Formulation	Inches Rain	Percent Mortality			Percent Defoliation		
		2 day	4 day	6 day	2 day	4 day	6 day
75 BFC	--	41	87	100	5	7	9
48 B	--	75	100		2	3	
75 BFC	.10	14	37	75	23	28	44
48 B	.10	14	45	64	21	48	58
75 BFC	.25	10	27	66	30	44	69
48 B	.25	4	14	41	24	69	69
75 BFC	.50	3	28	64	40	65	74
48 B	.50	0	15	36	40	79	79
75 BFC	1.0	4	8	33	38	62	81
48 B	1.0	0	2	11	43	83	90
Control	--	0	0	1	79	97	100
Control	1.0	0	0	1	54	100	

Table 16. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with *Bacillus thuringiensis* at 20 BIU/undiluted (neat) and exposed to rainfall.

Foray Formulation	Inches Rain	Percent Mortality			Percent Defoliation		
		2 day	4 day	6 day	2 day	4 day	6 day
75 BFC	--	60	90	99	2	3	3
48 B	--	65	95	99	2	2	2
75 BFC	.10	8	26	78	11	38	49
48 B	.10	8	45	79	9	34	41
75 BFC	.25	2	5	33	30	66	85
48 B	.25	1	3	7	32	74	79
75 BFC	.50	1	2	10	34	72	77
48 B	.50	7	16	40	34	64	75
75 BFC	1.0	0	3	21	32	62	76
48 B	1.0	3	5	14	28	64	86
Control	--	0	0	1	72	98	98
Control	1.0	0	0	0	68	100	

Table 17. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with *Bacillus thuringiensis* at 20 BIU/gal/a and exposed to rainfall.

	Inches	Percent Mortality			Percent Defoliation		
Formulation	Rain	2 day	4 day	6 day	2 day	4 day	6 day
Foray 75 BFC	--	48	83	93	6	8	9
Foray 48 B	--	58	96	100	3	3	3
Dipel 8 AF	--	51	98	100	4	4	4
Foray 75 BFC	1.0	1	36	59	34	54	60
Foray 48 B	1.0	0	13	38	42	66	80
Dipel 8 AF	1.0	2	35	53	32	40	40
Foray 75 BFC	2.0	4	28	68	26	48	64
Foray 48 B	2.0	2	48	83	30	34	47
Dipel 8 AF	2.0	0	43	89	28	44	56
Foray 75 BFC	3.0	0	25	70	46	50	60
Foray 48 B	3.0	0	19	44	38	70	78
Dipel 8 AF	3.0	0	39	73	24	28	33
Control	--	0	0	0	72	72	72
Control	3.0	0	1	1	80		

Table 18. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with *Bacillus thuringiensis* at 24 BIU/a undiluted (neat) and exposed to rainfall.

Formulation	Inches Rain	Percent Mortality			Percent Defoliation		
		2 day	4 day	6 day	2 day	4 day	6 day
Foray 75 BFC	--	53	94	98	4	7	7
Foray 48 B	--	63	100		3	3	
Dipel 8 AF	--	30	92	100	4	6	6
Foray 75 BFC	.10	18	61	94	22	40	44
Foray 48 B	.10	8	27	73	24	54	
Dipel 8 AF	.10	11	57	85	25	41	41
Foray 75 BFC	.25	9	56	87	32	50	50
Foray 48 B	.25	1	15	33	50	58	58
Dipel 8 AF	.25	9	51	82	28	40	42
Foray 75 BFC	.50	4	45	91	28	44	46
Foray 48 B	.50	0	5	27	52	74	
Dipel 8 AF	.50	1	22	59	30	56	62
Foray 75 BFC	1.0	4	23	64	40	64	68
Foray 48 B	1.0	0	11	41	46	66	71
Dipel 8 AF	1.0	2	49	80	32	42	46
Control	--	0	0	0	91	96	
Control	1.0	3	4	15	66	82	

Table 19. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with Foray 48B at 20 BIU/gal/a and exposed to rainfall after indoor and outside drying time.

Drying Time	Inches Rain	Percent Mortality			Percent Defoliation		
		2 day	4 day	6 day	2 day	4 day	6 day
1 hr. outside	--	79	100		1	1	
1 hr. outside	.25	6	52	81	10	22	30
2 hrs. outside	--	58	96	100	1	2	2
2 hrs. outside	.25	12	40	92	5	17	21
2 hrs. inside	--	67	98	99	1	2	2
2 hrs. inside	.25	6	25	65	18	41	42
Control							
2 hrs. outside	--	0	0	0	64		
2 hrs. inside	--	0	0	1	72	100	

Thuricide 64LV was tested and compared to other *Bacillus thuringiensis* formulations.

Table 20. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with *Bacillus thuringiensis* Bt formulations.

Formulation	BIU/Gal Acre	Larvae Mortality 2 day[1/]	Larvae Mortality 4 day	Larvae Mortality 6 day	Seedling Defoliation 2 day	Seedling Defoliation 4 day	Seedling Defoliation 6 day
Thuricide 64LV	20	10	59	97	34	45	46
Thuricide 48LV	20	8	80	100	22	37	38
Foray 48B	20	34	93	100	12	13	14
Dipel 8AF	20	31	83	98	9	13	17
Thuricide 64LV	12	8	64	94	24	34	38
Thuricide 48LV	12	9	57	97	22	48	48
Foray 48B	12	46	89	100	10	11	11
Dipel 8AF	12	10	66	94	18	21	33
Thuricide 64LV	6	3	38	93	30	48	63
Thuricide 48LV	6	3	50	85	38	47	48
Foray 48B	6	26	87	100	19	23	23
Dipel 8AF	6	8	43	83	25	47	58
Control	--	0	0	0	94	100	

[1/]Days of exposure to treated foliage.

Table 21. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with undiluted formulations of *Bacillus thuringiensis* Bt.

Formulation	BIU/ Acre	Larvae Mortality			Seedling Defoliation		
		2 day[1/]	4 day	6 day	2 day	4 day	6 day
Thuricide 64LV	20/40 oz.	11	56	96	8	28	28
Thuricide 48LV	20/53 oz.	23	85	99	11	20	22
Foray 48B	20/53 oz.	67	99	100	2	2	2
Dipel 8AF	20/40 oz.	36	93	100	3	7	8
Thuricide 64LV	12/24 oz.	10	42	89	23	48	56
Thuricide 48LV	12/32 oz.	17	75	99	14	32	35
Foray 48B	12/32 oz.	51	95	100	5	7	9
Dipel 8AF	12/24 oz.	21	71	99	6	19	21
Thuricide 64LV	6/12 oz.	0[2/]	0	15	67	86	94
Thuricide 48LV	6/16 oz.	8	54	89	12	24	31
Foray 48B	6/16 oz.	36	96	100	4	8	8
Dipel 8AF	6/12 oz.	40	88	97	6	8	10
Control	--	0	0	0	52	96	100

[1/]Days of exposure to treated foliage.
[2/]Delete - Poor treatment.

A number of laboratory tests were conducted with Margosan-O (Neem) from W. R. Grace Co. Field tests in 1990 resulted in poor results mainly because of wash-off and evaporation on the way to the target foliage. A number of stickers and anti evaporants were tested.

Table 22. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O and sticker then exposed to rainfall.

lbs. AI	Oz. of Conc.	Sticker	Inches	Percent Mortality		
gal/acre	per/acre	2%	Rain	14 day	20 day	25 day
.0216	Neat	--	--	65	100	100
.0216	Neat	--	.25	8	19	26
.0216	Neat	Surfix	.25	15	30	37
.0216	Neat	Bivert	.25	12	43	59
.0216	Neat	Anchor	.25	5	29	53
.0216	Neat	Plyac	.25	13	44	78
.0216	Neat	Sea Wet	.25	15	61	81
.0216	Neat	Spray Fuse	.25	19	65	83
.0216	Neat	Triton 1956	.25	31	61	77
.0216	Neat	CS-7	.25	34	82	92
Control	--	--	--	3	3	3
Control	--	--	.25	2	2	2

Table 23. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O at .0027 lbs. AI/gal/acre (16 oz. conc. per 128 oz.) and 2% sticker then exposed to rainfall.

Sticker	Inches Rain	Percent Mortality 10 day	14 day	28 day
--	--	8	62	98
--	.25	0	0	2
Poly Ag	.25	1	1	1
Rhoplex B-60A	.25	3	2	26
Bio Film	.25	3	3	23
Penetrator Plus	.25	2	3	9
K-27	.25	8	8	47
Stik	.25	1	1	3
No Foam	.25	1	1	5
Control	--	0	0	0
Control	.25	0	0	0

Table 24. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O at .0027 lbs. AI/gal/acre (16 oz. conc. per 128 oz.) and 2% sticker.

Sticker	Percent Mortality	
	16 day	20 day
--	96	99
Acrylocoat	77	96
Rhoplex B-60A	81	98
RA-1990	81	97
Plyac	89	96
CS-7	88	100
Triton B-1956	95	100
Bond	94	100
Control	1	17

Table 25. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O at .0027 lbs. AI/gal/acre (16 oz. conc. per 128 oz.) and 2% sticker then exposed to rainfall.

Sticker	Inches Rain	Percent Mortality 10 day	14 day	27 day
--	--	3	50	99
--	.25	2	2	2
Bond	.25	0	1	5
WFSI S-S	.25	0	0	12
Nu Lure	.25	0	0	12
R-56	.25	0	0	11
Chem-Stik	.25	0	1	3
Gelva 2397	.25	1	1	43
Acrylocoat	.25	0	0	9
Harvest Consulting	.25	2	2	20
Control	--	0	0	1
Control	.25	0	0	1

Table 26. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O at .0027 lbs. AI/gal/acre (16 oz. of conc. per 128 oz.) and 2% sticker then exposed to rainfall.

Sticker	Inches Rain	Percent Mortality 11 day	18 day	25 day
--	--	8	79	98
--	.25	0	0	8
Carboset 514-H	.25	5	8	18
CIB	.25	0	1	4
Sup-r-stik	.25	2	3	9
TS-85	.25	2	3	6
Gelva 2424	.25	0	1	3
Target NL	.25	0	3	5
Unite	.25	0	1	4
Pinolene 1882	.25	1	7	14
Control	--	0	0	1
Control	.25	0	0	0

Table 27. Percent larvae mortality following exposure to oak seedlings treated with various lot numbers of Margosan-O.

Dosage/Rate	Lot Number	Percent Mortality 11 day	18 day	25 day
.00067 lbs. AI - 4 oz. conc./gal	114	6	20	43
.00067 lbs. AI - 4 oz. conc./gal	WRC 120	6	17	72
.00067 lbs. AI - 4 oz. conc./gal	WRC 104	3	16	52
.00067 lbs. AI - 4 oz. conc./gal	--	4	24	57
.00027 lbs. AI - 4 oz. conc./gal	114	7	63	97
.00027 lbs. AI - 4 oz. conc./gal	WRC 120	18	71	99
.00027 lbs. AI - 4 oz. conc./gal	WRC 104	18	67	98
.00027 lbs. AI - 4 oz. conc./gal	--	20	82	99
Control	--	0	0	2

A test was conducted to determine the amount of exposure time gypsy moth larvae need to Margosan-O treated oak foliage to result in desirable larvae mortality.

Red oak seedlings were treated with Margosan-O at .0027 lbs. AI/gal/acre (16 oz. conc. in 128 oz./acre). Newly moulted, laboratory reared, 2nd instar larvae were exposed to seedlings for various amounts of time, removed and placed onto artificial diet and reared for 25 days. Larvae mortality readings were made at various times during the 25 day holding time.

Table 28. Percent larvae mortality following exposure to Margosan-O treated oak seedlings for various periods of time.

Hours Larvae Exposed to Treated Foliage	Percent Mortality 11 day	18 day	25 day
1	1	11	28
2	0	0	9
3	0	0	10
4	0	0	11
5	0	17	41
6	3	17	33
7	0	0	6
24	11	92	98
30	7	88	94
48	9	91	100
54	15	90	100
72	17	85	99
78	18	90	100
24 (Control)	0	0	6
48 (Control)	0	0	4
72 (Control)	0	0	4

A second exposure test was conducted with Margosan-O to test exposure times not covered in the first test. The same rate and dosage was used.

Table 29. Percent larvae mortality following exposure to Margosan-O treated oak seedlings for various periods of time.

Time Larvae Exposed to Treated Foliage	Percent Mortality					
	Treatment			Control		
	11 day	18 day	25 day	11 day	18 day	25 day
15 min.	0	0	16	1	2	25
30 min.	0	1	34	0	0	25
45 min.	0	0	22	0	0	25
7 hrs.	3	8	25	0	0	35
10 hrs.	6	21	31	0	0	47
14 hrs.	13	50	56	2	6	26
18 hrs.	14	78	82	1	4	30
22 hrs.	14	82	95	0	1	30
24 hrs.	16	91	99	0	4	45
27 hrs.	21	90	99	0	0	23

Poor results with Margosan-O in 1990 aerial spray studies were most likely due to the use of a formulation that was not the best for aerial application. As a result, a lot of evaporation of material occurred between the aircraft and target foliage resulting in little deposit and poor results.

Laboratory studies have started to develop a suitable formulation for field tests in 1992. Tests have been conducted with two carriers, Henderson and Promo. These tests will continue until a good aerial formulation is developed.

Table 30. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O at .00067 lbs. AI/gal/acre (4 oz. conc. per 128 oz./acre) and the Henderson and Promo carriers.

Formulation Carrier	Percent Mortality		
	11 day	18 day	25 day
31 ml water	4	13	28
15.5 ml Hen Em + 15.5 ml water	8	39	76
7.75 ml Hen Em + 23.25 ml water	4	34	65
23.25 ml Hen Em + 7.75 ml water	5	44	78
31 ml Hen No EM	8	61	89
7.75 ml Promo + 23.25 ml water	3	26	57
15.5 ml Promo + 15.5 ml water	5	25	74
23.25 ml Promo + 7.75 ml water	7	45	76
31 ml Promo	7	40	67
Control Hen Em	0	0	4
Control No Em	0	1	6
Control Promo	0	0	5
Control Untreated	0	0	1

Total amount of mix for each treatment was 31 ml
HEN EM - Henderson carrier with emulsifier
Promo - a low grade of cattle molasses

Table 31. Percent larvae mortality follow exposure to oak seedlings treated with Margosan-O at .00067 lbs. AI/gal/acre (4 oz. conc. per 128 oz./acre) with Henderson carrier, 2% Bond and exposed to rainfall.

Formulation Carrier	Sticker	Inches Rain	Percent Mortality 11 day	18 day	25 day
31 ml	--	--	7	22	40
	--	.25	1	2	3
	Bond	.25	0	1	2
7.75 ml Hen Em + 23.75 ml water	--	--	11	29	54
	--	.25	1	4	6
	Bond	.25	0	1	4
15.5 ml Hen Em + 15.5 ml water	--	--	6	24	60
	--	.25	0	0	0
	Bond	.25	0	1	12
23.25 ml Hen Em + 7.75 ml water	--	--	5	17	46
	--	.25	1	1	6
	Bond	.25	1	2	5
31 ml Hen	--	--	8	18	38
	--	.25	0	1	2
	Bond	.25	0	0	0
Control Hen Em	--	--	0	1	2
Control Hen No Em	--	--	0	0	2
Control Untreated	--	--	0	0	2

Total amount of mix for each treatment was 31 ml
HEN EM - Henderson carrier with emulsifier

Table 32. Percent larvae mortality following exposure to oak seedlings treated with Margosan-O at .00067 lbs. AI/gal/acre (4 oz. conc. per 128 oz./acre) with Promo carrier, 2% Bond and exposed to rainfall.

Formulation Carrier	Sticker	Inches Rain	Percent Mortality 11 day	18 day	25 day
31 ml	--	--	5	19	34
	--	.25	0	1	2
	Bond	.25	4	9	11
7.75 ml Promo + 23.75 ml water	--	--	9	45	77
	--	.25	0	2	7
	Bond	.25	0	4	5
15.5 ml Promo + 15.5 ml water	--	--	8	19	34
	--	.25	1	1	1
	Bond	.25	0	2	5
23.25 ml Promo + 7.75 ml water	--	--	5	14	27
	--	.25	1	1	1
	Bond	.25	2	3	8
31 ml Promo	--	--	6	24	44
	--	.25	0	3	4
	Bond	.25	2	5	8
Control 100% Promo	--	--	0	0	3
Control Untreated	--	--	0	0	4

Total of mix for each treatment was 31 ml
Promo - a low grade of cattle molasses

Much laboratory work was done with RH-5992, a new insect growth regulator from Rohm and Haas Co. Dimilin formulations were used as standards.

Table 33. Percent larvae mortality and seedling defoliation following exposure of 2nd instar gypsy moth larvae to seedlings treated with RH 5992 and Dimilin.

Formulation	Lbs./AI/Acre	Percent Mortality 7 day[1]	Percent Mortality 10 day	Percent Defoliation 4 day
RH 5992 20S	0.0312	96	100	25
RH 5992 2F	0.0312	99	100	24
Dimilin 25W	0.0312	92	100	74
Dimilin 4L	0.0312	96	100	56
Dimilin 2F	0.0312	86	100	70
RH 5992 20S	0.0156	89	100	36
RH 5992 2F	0.0156	98	100	37
Dimilin 25W	0.0156	97	100	80
Dimilin 4L	0.0156	81	100	62
Dimilin 2F	0.0156	87	100	78
RH 5992 20S	0.0078	98	100	41
RH 5992 2F	0.0078	83	100	39
Dimilin 25W	0.0078	94	100	72
Dimilin 4L	0.0078	94	100	82
Dimilin 2F	0.0078	84	100	66
RH 5992 20S	0.0039	76	100	49
RH 5992 2F	0.0039	69	95	59
Dimilin 25W	0.0039	90	100	72
Dimilin 4L	0.0039	92	100	87
Dimilin 2F	0.0039	89	100	62
Control	--	0	0	99

[1] Days following original exposure of test insects to treated plants.

Table 34. Percent larvae mortality and seedling defoliation following exposure of 2nd instar gypsy moth larvae to seedlings treated with RH 5992 and Dimilin.

Formulation	Lbs./AI/Acre	Percent Mortality 7 day[1]	10 day	18 day	Percent Defoliation 3 day
RH 5992 20S	.0039	67	87	94	42
RH 5992 2F	.0039	68	93	96	46
Dimilin 25W	.0039	94	100		91
Dimilin 4L	.0039	95	100		98
Dimilin 2F	.0039	57	100		98
RH 5992 20S	0.0019	47	72	85	52
RH 5992 2F	0.0019	61	91	95	46
Dimilin 25W	0.0019	90	99	100	98
Dimilin 4L	0.0019	92	99	100	96
Dimilin 2F	0.0019	83	96	99	95
RH 5992 20S	0.0009	29	50	55	68
RH 5992 2F	0.0009	59	89	92	72
Dimilin 25W	0.0009	28	98	100	95
Dimilin 4L	0.0009	74	91	100	88
Dimilin 2F	0.0009	66	98	100	99
RH 5992 20S	0.00048	6	13	18	84
RH 5992 2F	0.00048	13	42	43	72
Dimilin 25W	0.00048	16	91	100	98
Dimilin 4L	0.00048	53	89	100	100
Dimilin 2F	0.00048	22	89	99	99
Control	--	0	0	0	96

[1] Days following original exposure of test insects to treated plants.

Table 35. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with RH 5992 and Dimilin at 0.0312 lbs./AI/acre then exposed to rainfall.

		Percent Mortality		Percent Defoliation
Formulation	Inches Rain	7 day[1/]	10 day	4 day
RH 5992 20S	--	84	100	44
RH 5992 20S	0.5	68	100	42
RH 5992 20S	1.0	79	100	50
RH 5992 2F	--	80	100	36
RH 5992 2F	0.5	77	99	32
RH 5992 2F	1.0	66	99	40
Dimilin 25W	--	93	100	96
Dimilin 25W	0.5	87	100	84
Dimilin 25W	1.0	89	99	86
Dimilin 4L	--	91	100	98
Dimilin 4L	0.5	91	98	84
Dimilin 4L	1.0	94	98	88
Dimilin 2F	--	91	100	94
Dimilin 2F	0.5	93	99	88
Dimilin 2F	1.0	94	99	88
Control	--	0	0	100
Control	1.0	0	7	100

[1/] Days following original exposure of test insects to treated plants.

Table 36. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with RH 5992 and Dimilin at 0.0312 lbs./AI/acre then exposed to rainfall.

Formulation	Inches Rain	Percent Mortality 7 day[1/]	Percent Mortality 10 day	Percent Defoliation 3 day
RH 5992 20S	--	90	100	35
RH 5992 20S	2.0	79	97	37
RH 5992 20S	3.0	81	98	32
RH 5992 2F	--	78	100	33
RH 5992 2F	2.0	68	99	39
RH 5992 2F	3.0	78	99	42
Dimilin 25W	--	98	100	89
Dimilin 25W	2.0	97	100	97
Dimilin 25W	3.0	100	100	98
Dimilin 4L	--	97	100	91
Dimilin 4L	2.0	94	100	97
Dimilin 4L	3.0	95	100	86
Dimilin 2F	--	99	100	99
Dimilin 2F	2.0	100	100	89
Dimilin 2F	3.0	99	100	98
Control	--	0	0	100
Control	3.0	0	0	100

[1/] Days following original exposure of test insects to treated plants.

Table 37. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with RH 5992 and Dimilin at 0.03 lbs./AI/acre then exposed to rainfall.

Formulation	Inches Rain	Percent Mortality 7 day[1/]	Percent Mortality 10 day	Percent Defoliation 3 day
RH 5992 20S	--	89	100	42
RH 5992 20S	4.0	75	100	42
RH 5992 20S	5.0	85	98	41
RH 5992 2F	--	92	100	40
RH 5992 2F	4.0	82	99	31
RH 5992 2F	5.0	84	100	47
Dimilin 25W	--	98	100	97
Dimilin 25W	4.0	100		95
Dimilin 25W	5.0	99	100	94
Dimilin 4L	--	97	100	100
Dimilin 4L	4.0	94	100	84
Dimilin 4L	5.0	98	100	89
Dimilin 2F	--	96	100	97
Dimilin 2F	4.0	98	100	87
Dimilin 2F	5.0	99	100	95
Control	--	0	0	96
Control	5.0	0	2	99

[1/] Days following original exposure to test insects to treated plants.

Table 38. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with RH 5992 and Dimilin at 0.0078 lbs./AI/acre then exposed to rainfall.

Formulation	Inches Rain	Percent Mortality 10 day[1/]	Percent Defoliation 3 day
RH 5992 20S	--	98	40
RH 5992 20S	0.5	95	42
RH 5992 20S	1.0	98	42
RH 5992 2F	--	98	48
RH 5992 2F	0.5	96	44
RH 5992 2F	1.0	99	46
Dimilin 25W	--	100	90
Dimilin 25W	0.5	100	88
Dimilin 25W	1.0	100	86
Dimilin 4L	--	100	100
Dimilin 4L	0.5	100	98
Dimilin 4L	1.0	100	96
Dimilin 2F	--	100	90
Dimilin 2F	0.5	100	100
Dimilin 2F	1.0	100	86
Control	--	1	98
Control	1.0	0	100

[1] Days following original exposure of test insects to treated plants.

Table 39. Percent larvae mortality and seedling defoliation following exposure to oak seedlings treated with RH 5992 and Dimilin at 0.0078 lbs./AI/acre then exposed to rainfall.

		Percent Mortality		Percent Defoliation
Formulation	Inches Rain	7 day[1/]	10 day	3 day
RH 5992 20S	--	91	100	39
RH 5992 20S	3.0	80	97	40
RH 5992 20S	5.0	70	97	50
RH 5992 2F	--	79	99	45
Rh 5992 2F	3.0	72	92	52
RH 5992 2F	5.0	71	94	50
Dimilin 25W	--	100		88
Dimilin 25W	3.0	100		86
Dimilin 25W	5.0	100		90
Dimilin 4L	--	100		84
Dimilin 4L	3.0	100		92
Dimilin 4L	5.0	100		86
Dimilin 2F	--	99	100	92
Dimilin 2F	3.0	100		86
Dimilin 2F	5.0	100		84
Control	0	0	0	100
Control	0	0	0	96

[1/] Days following original exposure of test insects to treated plants.

Three laboratory tests were conducted with RH 9999 using Margosan-O as a standard. Following a 3 day exposure of test larvae to treated plants, all test insects were removed from the skeletonized plants and placed on untreated artificial diet. Larvae mortality readings were made for 21 days as death usually occurs with these types of materials following a two week post treatment period.

Table 40. Percent gypsy moth larvae mortality following exposure to red oak seedlings treated with RH 9999 and Margosan-O.

Formulation	Lbs.AI/Gal/Acre	Percent Mortality 10 day[1/]	14 day	18 day	21 day	Percent Defoliation 3 day
RH 9999 21%	0.25	6	70	100		73
RH 9999 21%	0.10	2	18	82	97	78
RH 9999 21%	0.05	2	25	89	96	92
RH 9999 21%	0.025	5	23	87	98	73
RH 9999 21%	0.012	3	32	86	96	87
Margosan-O	0.025	3	45	93	100	83
Margosan-O	0.012	13	43	91	100	67
Control	--	1	1	2	2	100

[1/] Days following original exposure of test insects to treated plants.

Table 41. Percent gypsy moth larvae mortality following exposure to red oak seedlings treated with RH 9999 + .06 percent Triton 1956 and Margosan-O at 0.025 lbs.AI/gal/acre and exposed to rainfall.

Formulation	Inches Rain	Percent Sticker	Percent Mortality 10 day[1/]	14 day	18 day	21 day	Percent Defoliation 3 day
RH 9999 21%	--	--	2	28	85	97	87
RH 9999 21%	0.1	--	3	27	83	98	87
RH 9999 21%	0.25	--	2	15	36	47	88
RH 9999 21%	--	2% Bond	5	32	87	97	84
RH 9999 21%	0.1	2% Bond	2	32	84	100	87
RH 9999 12%	0.25	2% Bond	2	33	80	95	89
Margosan-O	--	--	6	38	90	100	86
	0.1	--	5	10	20	27	96
	0.25	--	0	7	24	30	97
Control	--	--	0	0	0	0	95
Control	0.25	--	0	0	0	0	100

[1/] Days following original exposure of test insects to treated plants.

Table 42. Percent gypsy moth larvae mortality following exposure to red oak seedlings treated with RH 9999 + .06 percent Triton 1956 and Margosan-O at 0.025 lbs.AI/gal/acre and exposed to rainfall.

Formulation	Inches Rain	Percent Sticker	Percent Mortality 10 day[1]	14 day	18 day	21 day	Percent Defoliation 3 day
RH 9999 21%	--	--	6	41	94	100	72
RH 9999 21%	0.5	--	1	16	31	34	85
RH 9999 21%	1.0	--	0	3	14	18	87
RH 9999 21%	--	2% Bond	1	22	91	100	73
RH 9999 21%	0.5	2% Bond	5	16	66	77	85
RH 9999 21%	1.0	2% Bond	1	11	44	59	96
Margosan-O	--	--	5	51	99	100	87
Margosan-O	0.5	--	1	3	9	9	99
Margosan-O	1.0	--	1	7	29	36	85
Control	--	--	1	1	1	1	100
Control	--	--	1	1	1	1	96

[1] Days following original exposure of test insects to treated plants.

A number of experimental Bt samples from Mycogen were tested in the laboratory.

AGRISENSE PHEROMONE BEADS

A field test with beads was attempted in 1990 and was terminated prior to completion due to a number of formulation and application problems. Beads would not stay suspended in the formulation of water and RA 1990 sticker, the formulation ingredients were not compatible and beads had a tendency to build-up under the diaphragms causing poor shut-off of spray at the end of each run.

Following the 1990 field problems, a number of materials were tested in the laboratory to identify formulations that might be tested in the aircraft at Mission, Texas in January 1991.

The following thickening agents were tested:

Soilserve	Nalquatic
Surfix	STA-PUT
Induce	Van Gel B
Blendex	Mist Control
Penetration	Rhodopol
HM-8802-A	Natrosol
Polyox	

Stickers tested were:

Bivert	No Foam
Poly AG	Bond
Clear Spray	Spray Fuse

Candidate materials were mixed in small amounts (50 ml) to determine compatibility and deposited onto red oak foliage that was then exposed to rainfall to determine the formulations resistance to wash-off.

As a result of these tests, four formulations were selected to be tested at Mission, Texas in January 1991. In priority they are:

1. Nalquatic .25% by volume
   Bond 2% by volume
   Beads 75 gms (30.4% AI)/gal/acre
   Water

2. STA-PUT 10% by volume
   Bond 2% by volume
   Beads 75 gms (30.4% AI)/gal acre
   Water

3. Natrosol 5% by volume
   Bond 2% by volume
   Beads 75 gms (30.4% AI)/gal/acre
   Water

4. Rhodopol 23 .5% by volume
   Bond 2% by volume
   Beads 75 gms (30.4% AI)/gal/acre
   Water

Bond®, a registered agricultural sticker from Loveland Industries, was the most effective sticker tested. This sticker is readily available and has been used for years in pesticide formulations without causing problems with pump seals or spray systems.

Viscosity tests were conducted with each thickener after it was added to water. These tests did not include the complete formulation with beads and sticker as beads are in short supply. Tests were done with a LV viscosimeter with No. 2 spindle at 60 RPM's.

Nalquatic .25% in water

Temperature	CPS
70°F	60
75°F	60
80°F	56
85°F	53
90°F	50
95°F	47
100°F	46
105°F	42
110°F	40

Natrosol 2.5% in water (a limited supply of material resulted in 2.5% Natrosol being d for this test.

Temperatures	CPS
70°F	21.5
75°F	27
80°F	24.5
85°F	23
90°F	25
95°F	24
100°F	19
105°F	18
110°F	15

Rhodopol 12 .5% in water

Temperature	CPS
70°F	222.5
75°F	215
80°F	213
85°F	205
90°F	195
95°F	185
100°F	172.5
105°F	162.5
110°F	152

Nalquatic, a liquid formulation mixed very well with water at 66°F and thickening was immediate. Beads were then added and 2% Bond sticker last. The beads and sticker mixed very well with the Nalquatic and the final mix looked very workable. The viscosity of the mix was affected more than the other mixes by temperature change. The mix did continue to keep the beads suspended at all temperatures tested.

Sixty gallons of the mix was sprayed through a flat fan spray tip No. 8010 with no problems. Positive shut-off was good and very few beads congregated under the nozzle diaphragm. The material stayed in the nurse tank for a 24 hour period with no apparent negative affects.

This mix was rated No. 1 priority because of the thickening agent being liquid and its fast activity in water of 66°F using light agitation. Also because of the small amount needed and for its ability to keep the beads suspended.

STA-PUT was rated No. 2 in priority, mainly because it is likely to be used in the Forest Services seed orchard program. The material is also liquid and the thickening was accomplished in about 10 minutes in water 66°F with light agitation. The formulation viscosity was affected least of the 4 mixed when exposed to a range of temperatures. The positive shut-off appeared to be slower with this mix than any of the others. A much greater amount of this material is needed to acquire a set amount of thickness. The beads do not suspend as well in this formulation as with Nalquatic.

Natrosol, a powder formulation is harder to mix with water at 66°F, but once mixed and the thickening has taken place, it is a good workable formulation. The main problem is the time period of 30+ minutes it takes for the water to thicken.

Viscosity was fairly stable when exposed to various temperatures. Beads suspended better in this mix than the STA-PUT formulation but not as good as the Nalquatic mix.

Rhodopol 23, another powder was slow in mixing and thickening action at 66°F. About one hour is needed to get a good smooth mix. Once mixed, the formulation suspended the beads well and was fairly stable at various temperatures.

Each formulation was sprayed onto red oak foliage, dried for 2.5 hours and then exposed to rainfall. Beads on foliage were counted prior and following exposure to rain to determine percentage of beads staying on foliage. Bond proved to be the most effective sticker. Bond was tested with Nalquatic using a number of sticker dosages and results indicate that the sticker can be effective at dosages as low as 1.0 percent by volume.

Table 43. Disparlure Bead Test with Natrosol at 3% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + 3% Natrosol + 2% BOND + H_2O	94	94	91	87
Beads + 3% Natrosol + 2% Clearspray + H_2O	95	68	55	11
Beads + 3% Natrosol + 2% Poly Ag + H_2O	97	36	6	1
Beads + 3% Natrosol + 2% Bivert + H_2O	89	88	85	33
Beads + 3% Natrosol + 2% Spray Fuse + H_2O	89	89	89	66
Beads + 3% Natrosol + 2% No Foam + H_2O	93	84	62	37
Beads + 3% Natrosol + H_2O	100	52	6	6
Beads + H_2O	16	2	0	0

[1/]Inches rain

Table 44. Disparlure Bead Test with Nalquatic at .25% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + .25% Nalquatic + 2% BOND + H_2O	100	97	96	88
Beads + .25% Nalquatic + 2% Clearspray + H_2O	83	80	75	68
Beads + .25% Nalquatic + 2% Poly Ag + H_2O	7	1	0	0
Beads + .25% Nalquatic + 2% Spray Fuse + H_2O	5	0	0	0
Beads + .25% Nalquatic + 2% No Foam + H_2O	0	0	0	0
Beads + .25% Nalquatic + H_2O	23	4	0	0
Beads + H_2O	0	0	0	0

[1/]Inches rain

Table 45. Disparlure Bead Test with STA-PUT at 20% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + 20% STA-PUT + 2% BOND + H_2O	100	121	100	100
Beads + 20% STA-PUT + 2% Clearspray + H_2O	86	80	75	59
Beads + 20% STA-PUT + 2% Bivert + H_2O	21	0	0	0
Beads + 20% STA-PUT + 2% Spray Fuse + H_2O	0	0	0	0
Beads + 20% STA-PUT + 2% No Foam + H_2O	48	2	0	0
Beads + 20% STA-PUT + 2% Poly Ag + H_2O	66	20	19	16
Beads + 20% STA-PUT + H_2O	22	7	1	1
Beads + H_2O	15	0	0	0

[1/]Inches rain

Table 46. Disparlure Bead Test with Rhodopol 23 at .5% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + .5% Rhodopol 23 + 2% BOND + H_2O	100	100	56	41
Beads + .5% Rhodopol 23 + 2% STA-PUT + H_2O	87	96	70	37
Beads + .5% Rhodopol 23 + 2% Clearspray + H_2O	93	69	63	19
Beads + .5% Rhodopol 23 + 2% Bivert + H_2O	61	63	25	6
Beads + .5% Rhodopol 23 + 2% Poly Ag + H_2O	69	30	25	0
Beads + .5% Rhodopol 23 + 2% Spray Fuse + H_2O	104	58	10	6
Beads + .5% Rhodopol 23 + 2% No Foam + H_2O	74	80	66	13
Beads + .5% Rhodopol 23 + H_2O	103	94	19	7
Beads + H_2O	11	0	0	0

[1/]Inches rain

Table 47. Disparlure Bead Test with Nalquatic at .25% v/v and various amounts of BOND sticker (beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + .25% Nalquatic + 2% BOND + H_2O	100	100	100	100
Beads + .25% Nalquatic + 1.5% BOND + H_2O	99	99	97	97
Beads + .25% Nalquatic + 1.0% BOND + H_2O	84	84	84	84
Beads + .25% Nalquatic + .75% BOND + H_2O	86	77	77	59
Beads + .25% Nalquatic + .5% BOND + H_2O	86	68	64	54
Beads + .25% Nalquatic + .25% BOND + H_2O	82	48	48	52
Beads + .25% Nalquatic + .10% BOND + H_2O	6	6	4	0
Beads + .25% Nalquatic + .05% BOND + H_2O	12	1	0	0
Beads + .25% Nalquatic + H_2O	9	1	0	0
Beads + H_2O	2	1	0	0

[1/]Inches rain

For the past 2 years, laboratory and field work has been conducted with AgriSense beads containing gypsy moth pheromone. Tests have been designed to cause mating disruption of the gypsy moth. Currently used Hercon laminate flakes have to be distributed from specially designed pods mounted on high-wing aircraft such as the Cessna 206. This equipment has proven to be less then desirable for applying the Hercon formulation and, therefore, diminishes the likelihood of its use. A more desirable technique would be a pheromone formulation in liquid that can be sprayed out of the standard boom and nozzle.

The experimental AgriSense bead formulation was tested in Virginia in 1990. A number of problems with the formulation and equipment prevented its use on the designated experimental acreage. Beads did not suspend well in the formulation and they also congregated under nozzle diaphragms.

During January, 1991 new bead formulations were tested successfully at the USDA, APHIS aircraft operations, Moore Air Base, Mission, Texas. The test formulations were sprayed from a Cessna Ag-Truck aircraft using boom and nozzle. A red CP nozzle with CP check valve body was used. Nineteen spray runs were made over a line of red 4 x 5 inch kromekote spray cards (see table 1). This resulted in various types of deposit on the cards depending on the nozzles used and there orientation on the boom. In general, large (3-9 beads) drops and small (1-2 beads) drops were collected on the spray cards.

It is important that the droplets with beads suspend to the foliage throughout the forest canopy. Beads should be resistant to wind and rainfall. Two percent Bond sticker is added to the formulation to aid its ability to stick to the smooth oak foliage.

Prior to the Mission tests, each formulation was subjected to weathering tests in the laboratory at the Otis Center (Tables 49-53). Formulations were sprayed onto red oak foliage, dried for 2.5 hours and then exposed to rainfall. Beads on foliage were counted prior and following exposure to rain to determine percentage of beads staying on foliage. With Bond added to the formulations, good retention was achieved with as much as 2 inches of rainfall.

Sprayed cards from the Mission tests were returned to Otis Center and tested for bead weathering characteristics. These tests were conducted about 65 days following treatment in Mission, Texas (Table 54). Results indicate good retention of both clusters and individual beads when exposed to 0.5 inches of rainfall. An average of 69 percent of individual and 88 percent of clusters were recovered following rainfall. This would indicate that we are safe to use equipment and formulations of StaPut or Nalquatic that produce individual or clusters of beads on the target foliage.

Because of the smooth surface area of the card, one would expect more severe wash-off of beads from the cards than the foliage.

Table 48. Summary of Tests

Test No.	Spray Date	Tank Mix[1]	Nozzles[2] (positioned): 2 per Wing
3	1/23	2% Bond; 0.75 NQ[3]	Red CP nozzles (aft); big hole under nozzle & 90°slash plate
4	1/23	2% Bond; 0.75 NQ[3]	Red CP nozzles (down); big hold forward & 90° splash plate
5	1/23	2% Bond; 0.75 NQ[3]	Red CP nozzles (down); big hole aft & 90° splash plate
6	1/23	2% Bond; 0.75 NQ[3]	Red CP nozzles (aft); big hole on top of nozzle & 90° splash plate
7	1/23	2% Bond; 0.75 NQ[3]	12" x ¼" OD Cu pipes (down) on CP check valve bodies
8	1/23	2% Bond; 0.75 NQ[3]	1.5" x ¼" OD SS pipes (45° forward) on CP check valve bodies
9	1/23	2% Bond; 0.75 NQ[3]	1.5" x ¼" OD SS pipes (45° forward) on CP check valve bodies
10[4]	1/24	2% Bond; 10% StaPut	Red CP nozzles (down); big hole aft & 90° splash plate
11	1/24	2% Bond; 10% StaPut	Red CP nozzles (down); big hole aft & 45° splash plate
12	1/24	2% Bond; 10% StaPut	4" x ¼" OD Cu pipes (aft); no valves
13	1/24	2% Bond; 50% StaPut	4" x ¼" OD Cu pipes (aft); no valves
14	1/24	2% Bond; 50% StaPut	Red CP nozzles (down); big hole aft & 90° splash plate
15	1/24	2% Bond; 50% StaPut	Red CP nozzles (down); big hole aft & 45° splash plate
17	1/25	2% Bond; 0.25 NQ[3]	Red CP nozzles (down); big hole aft & 90° splash plate
18	1/25	2% Bond; 0.25 NQ[3]	4" x ¼" OD Cu pipes (aft); no valves
19	1/25	2% Bond; 0.25 NQ[3]	1.5" x ¼" OD SS pipes (aft) on CP check valve bodies
20	1/25	2% Bond; 0.75 NQ[3]	Red CP nozzles (down); big hole aft & 90° splash plate
21	1/25	2% Bond; 0.75 NQ[3]	4" x ¼" OD Cu pipes (aft); no valve
22	1/25	2% Bond; 0.75 NQ[3]	1.5" x ¼" OD SS pipes (aft) on CP check valve bodies

1. All tank mixes (v/v), with the exception of tests 13, 14 and 15, contained 75 g beads/gal; tests 13, 14 and 15 contained about one-half of that quantity.

2. All mixing was done in the aircraft hopper; beads were pre-mixed prior to being added to the hopper. The mixing order was: water, thickener, beads, and sticker. Red CP nozzles = red plastic nozzles with check valve bodies. All nozzles were connected directly into the spray boom with no shut-off between the nozzle body and the boom. Runs 3-15 were applied using 52 psi and runs 17-22 with 40 psi (run 16 was not completed). 45° forward = nozzle orfice pointing 45° into slip stream when spraying; down = nozzle orfice pointing straight down when spraying; aft = nozzle orfice pointing aft of aircraft when spraying.

3. NQ = Nalquatic

4. Cards were sprayed on 2 passes; therefore, bead quantities were divided by 2.

Table 49.

Disparlure Bead Test with Natrosol at 3% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + 3% Natrosol + 2% BOND + H_2O	94	94	91	87
Beads + 3% Natrosol + 2% Clearspray + H_2O	95	68	55	11
Beads + 3% Natrosol + 2% Poly Ag + H_2O	97	36	6	1
Beads + 3% Natrosol + 2% Bivert + H_2O	89	88	85	33
Beads + 3% Natrosol + 2% Spray Fuse + H_2O	89	89	89	66
Beads + 3% Natrosol + 2% No Foam + H_2O	93	84	62	37
Beads + 3% Natrosol + H_2O	100	52	6	6
Beads + H_2O	16	2	0	0

[1/]Inches rain

Table 50.
Disparlure Bead Test with Nalquatic at .25% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + .25% Nalquatic + 2% BOND + H_2O	100	97	96	88
Beads + .25% Nalquatic + 2% Clearspray + H_2O	83	80	75	68
Beads + .25% Nalquatic + 2% Poly Ag + H_2O	7	1	0	0
Beads + .25% Nalquatic + 2% Spray Fuse + H_2O	5	0	0	0
Beads + .25% Nalquatic + 2% No Foam + H_2O	0	0	0	0
Beads + .25% Nalquatic + H_2O	23	4	0	0
Beads + H_2O	0	0	0	0

[1/]Inches rain

Table 51.
Disparlure Bead Test with STA-PUT at 20% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + 20% STA-PUT + 2% BOND + H_2O	100	121	100	100
Beads + 20% STA-PUT + 2% Clearspray + H_2O	86	80	75	59
Beads + 20% STA-PUT + 2% Bivert + H_2O	21	0	0	0
Beads + 20% STA-PUT + 2% Spray Fuse + H_2O	0	0	0	0
Beads + 20% STA-PUT + 2% No Foam + H_2O	48	2	0	0
Beads + 20% STA-PUT + 2% Poly Ag + H_2O	66	20	19	16
Beads + 20% STA-PUT + H_2O	22	7	1	1
Beads + H_2O	15	0	0	0

[1/]Inches rain

Table 52.
Disparlure Bead Test with Rhodopol 23 at .5% v/v and various stickers at 2% v/v. Beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + .5% Rhodopol 23 + 2% BOND + H_2O	100	100	56	41
Beads + .5% Rhodopol 23 + 2% STA-PUT + H_2O	87	96	70	37
Beads + .5% Rhodopol 23 + 2% Clearspray + H_2O	93	69	63	19
Beads + .5% Rhodopol 23 + 2% Bivert + H_2O	61	63	25	6
Beads + .5% Rhodopol 23 + 2% Poly Ag + H_2O	69	30	25	0
Beads + .5% Rhodopol 23 + 2% Spray Fuse + H_2O	104	58	10	6
Beads + .5% Rhodopol 23 + 2% No Foam + H_2O	74	80	66	13
Beads + .5% Rhodopol 23 + H_2O	103	94	19	7
Beads + H_2O	11	0	0	0

[1/]Inches rain

Table 53.
Disparlure Bead Test with Nalquatic at .25% v/v and various amounts of BOND sticker (beads mixed at 75gms/gal/solution.

MIXTURES	Average percentage of beads remaining after weathering			
	.25"[1/]	.50"	1.0"	2.0"
Beads + .25% Nalquatic + 2% BOND + H_2O	100	100	100	100
Beads + .25% Nalquatic + 1.5% BOND + H_2O	99	99	97	97
Beads + .25% Nalquatic + 1.0% BOND + H_2O	84	84	84	84
Beads + .25% Nalquatic + .75% BOND + H_2O	86	77	77	59
Beads + .25% Nalquatic + .5% BOND + H_2O	86	68	64	54
Beads + .25% Nalquatic + .25% BOND + H_2O	82	48	48	52
Beads + .25% Nalquatic + .10% BOND + H_2O	6	6	4	0
Beads + .25% Nalquatic + .05% BOND + H_2O	12	1	0	0
Beads + .25% Nalquatic + H_2O	9	1	0	0
Beads + H_2O	2	1	0	0

[1/]Inches rain

Table 54. Percent of AgriSense beads remaining on Red Kromekote Cards after Exposure to 0.5 Inches of Rainfall.

Test Run	Single Bead	Cluster of Beads
3	33.3	62.3
4	62.7	97.7
5	100	92.3
6	51	78.7
7	66.3	72.3
8	85.5	96.7
9	66.5	89.3
10	82	96
11	58.7	98.3
12	87.7	89.7
13	80	95.7
14	--	99.3
15	46.7	100
17	66.3	85
18	84.3	93
19	66.7	48
20	91.7	99
21	70	87.3
22	50	88
Average	69	88

A 3 gallon mix of experimental AgriSense gypsy moth pheromone formulation was prepared in a mini spray system and used to calibrate the CP nozzle and check valve body prior to aircraft application in Virginia during June.

Water 299.52 oz.
StaPut 76.80 oz. (20% v/v)
Bond 7.68 oz. (2% v/v)

The stainless steel check valve and red CP nozzle that was tested at Moore Field, Mission, Texas in January was used in these tests. Each calibration was replicated a minimum of 4 times using 15 second runs for each at 40 psi. All 3 orfice sizes were checked for flow rate. Nozzles were pointing straight down and screwed directly into the aircraft spray boom.

1) Large orfice - Small knobs on nozzle pointing forward and orfice selector knob all the way to the right as you stand in back of aircraft looking in the direction of flight.

Run	Time	Amount	
1	15 Sec	2700ml	Avg: 2712.5ml x 4 =
2	15 Sec	2650ml	10850ml ÷ 3785 =
3	15 Sec	2760ml	2.9 gal/min

2) Medium orfice - Small knob on nozzle pointing forward and orfice selector knob all the way to the left as you stand in back of aircraft looking in the direction of flight.

Run	Time	Amount	
1	15 Sec	2160ml	Ave: 2185ml x 4 =
2	15 Sec	2200ml	8740ml ÷ 3785ml =
3	15 Sec	2200ml	2.3 gal/min
4	15 Sec	2180ml	

3) Small orfice - Small knobs on nozzle pointing forward and orfice selector knob directly on 2nd small knob to right as you stand in back of aircraft looking in the direction of flight.

Run	Time	Amount	
1	15 Sec	940ml	Avg: 936ml x 4 =
2	15 Sec	920ml	3744ml ÷ 3785ml =
3	15 Sec	900ml	.99 gal/min
4	15 Sec	940ml	
5	15 Sec	940ml	
6	15 Sec	950ml	
7	15 Sec	960ml	

The same formulation with 5 percent Bond sticker was tested for flow rate using this small orfice.

Run	Time	Amount	
1	15 Sec	920	Avg: 932ml x 4 =
2	15 Sec	930	3728ml ÷ 3785ml =
3	15 Sec	950	.98 gal/min
4	15 Sec	940	
5	15 Sec	920	

Approximately 100 gallons of the 5 percent Bond sticker formulation of pheromone was passed through the CP nozzle using 40psi. Positive shut-off continued to be good and the system continued to function properly. All calibration work was done with the formulation temperature being 95°F.

Water was added to the spray tank, then StaPut, then beads followed by sticker. Before adding beads, they should be pre mixed in a 5 gallon bucket with the water and StaPut mix. There should be light to moderate agitation in the tank as each material is added.

When at Mission, Texas in January, 1991, a series of spray runs over cards were made with Dimilin 4L and Dimilin 25W. A number of adjuvants were tested with the Dimilin 4L formulation. The standard 1986 adjuvant is more effective than others tested. The Dimilin 4L handled very well and dispersed form the aircraft with no problems. There was no buildup of material on in-line on nozzle screens (50 mesh).

Handling and dispersal studies were also conducted at Mission with Foray 75B and Thuricide 64LV. There were no problems in handling or spraying either formulation.

Native egg masses were treated in the field with 4 formulations of Ficam W (Bendiocarb) to the point of run-off. Twenty masses were treated with each formulation monthly from October through April. In mid April all egg masses were collected and returned to the laboratory for hatchability tests. Hatch occurred in all egg masses with all treatments over the seven month period.

Foray 48LV was tested with mist blower and hydraulic sprayer on 40,000 sq. ft. plots with a road through the middle of each. RH-5992 was also tested with mist blower only. Burlap was placed on 10 trees in each plot and larvae counts made under each following spraying. Post spray egg mass counts have not been made at this time.

There appears to be a significant difference between the types of treatment but little difference between rates of application.

Treatment	Type/ Application	Avg. Live Larvae/Tree/Treatment				Avg. of Treatment Dates
		5/15/91	5/22/91	5/29/91	6/5/91	
Foray 48B 12 BIU/10 gal.	Mist Blower	8	9	13	28	14
Foray 48B 12 BIU/30 gal.	Mist Blower	9	6	9	22	12
Foray 48B 24 BIU/10 gal.	Mist Blower	12	23	38	55	32
Foray 48B 24 BIU/30 gal.	Mist Blower	8	8	16	30	16
Foray 48B 12 BIU/50 gal.	Hydraulic Sprayer	24	49	82	164	80
Foray 48B 12 BIU/100 gal.	Hydraulic Sprayer	12	30	55	137	58
Foray 48B 24 BIU/50 gal.	Hydraulic Sprayer	7	10	13	41	18
Foray 48B 24 BIU/100 gal.	Hydraulic Sprayer	14	33	76	156	70
RH-5992 .03 lb/30 gal.	Mist Blower	16	10	12	27	16
Control		19	25	24	121	47

Treatment	Type Application	Percent Defoliation
Foray 48B 12 BIU/10 gal.	Mist Blower	50
Foray 48B 12 BIU/30 gal.	Mist Blower	40
Foray 48B 24 BIU/10 gal.	Mist Blower	50
Foray 48B 24 BIU/30 gal.	Mist Blower	29
Foray 48B 12 BIU/50 gal.	Hydraulic Sprayer	91
Foray 48B 12 BIU/100 gal.	Hydraulic Sprayer	86
Foray 48B 24 BIU/50 gal.	Hydraulic Sprayer	74
Foray 48B 24 BIU/100 gal.	Hydraulic Sprayer	88
RH-5992 .0316/30 gal.	Mist Blower	<10
Control		90

A 75 acre isolated gypsy moth infestation in Warren County, Ohio was treated with 2 applications of Gypchek. Applications were made 5 days apart and foliage was extended 30 percent. An APHIS Cessna Ag-truck aircraft applied the material using 8006 flat fan spray tips with a dosage and rate of $1x10^{12}$/2 gal/acre.

Prior to treatment, 17 male moths were captured in one trap during 1989. The site was delimited in 1990 and 17 moths were captured in 6 traps. A visual survey was done in 1990 and no life stages were found.

For evaluation, 75 burlaps were placed around red and white oak trees and the area was extensively trapped in 1991 following treatment. No larvae, pupae or egg masses were found under the burlap and no male moths were captured in the traps.

Win McLane
September 1991

Report of Mission, Texas, Experiments on Spraying AgriSense Beads Containing Disparlure

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SUMMARY

The spray tests conducted in Mission, Texas, January 22-25, 1991, successfully showed that the AgriSense polymeric beads containing 40% racemic disparlure can be sprayed with a conventional aircraft spray system using special nozzles. Both a thickening agent and a sticker must be added to a water slurry of the beads to suspend the beads in the tank mix and to adhere the beads on foliage. Two thickening agents, 0.75% Nalquatic and 10% StaPut, were found to be adequate and one will be selected based on subsequent laboratory tests. The sticker, 2% Bond, was used in all spray-test formulations and was shown to provide adequate bead adhesion in laboratory tests. With either Nalquatic or StaPut thickening agent, a relatively large amount of beads were deposited in clusters, as desired. The adhesion of individual and clustered beads when exposed to rainfall will continue to be tested in the laboratory. The disparlure release rates from the formulated mixes will also be measured prior to selection of the thickening agent to be used in the cooperative Forest Service field program in Virginia in June 1991.

Conventional flat-fan nozzles did not work well with bead formulations; No. 8004 nozzles plugged and No. 8010-8030 nozzles had bead buildup at the diaphragms resulting in poor shut-off. CP check valves provided positive shut-off during aerial application. On the other hand, red plastic CP nozzles or 1.5" x 1/4" OD pipe nozzles gave good spray characteristics when attached to these CP check valves. In addition, 4" x 1.4" OD copper pipe nozzles with no shut-off valves also effectively delivered bead formulations but a shut-off system must be developed for these nozzles to be used operationally. The nozzle system to be used in the cooperative Forest Service field program in Virginia (June 1991) will be selected by the Gypsy Moth Mating Disruption Committee at the March 11 meeting based on recommendations made to the Committee by Win McLane.

INTRODUCTION

The use of polymeric beads to deliver effective doses of racemic disparlure offers a distinct advantage over the currently used Hercon laminate flakes for mating disruption of the gypsy moth. The beads can be delivered by conventional aircraft spray systems with special nozzles while the flakes and accompanying sticker must be distributed from specially designed pods mounted on high-wing aircraft such as the Cessna 206.

Therefore, a cooperative research program was undertaken in 1989 by the Insect Chemical Ecology Laboratory, ARS, Beltsville, MD, and AgriSense, Fresno, CA, to develop an

effective bead formulation for racemic disparlure to be used in federal and state gypsy moth mating disruption trials. A preliminary evaluation of the chosen bead formulation was attempted by FS/APHIS in Giles County, VA in June 1989. However, significant difficulties occurred with the formulation and the delivery system. As a result, W. McLane (APHIS - Otis Methods Development Laboratory, MA) carried out laboratory evaluations of various combinations of stickers and thickening agents which are necessary to adhere and suspend the beads. His results were distributed in Mission, TX, and can be obtained from him on request.

A group of interested parties was assembled in Mission, TX, at Moore Air Base Facility, January 22-25, to test aircraft spray systems with bead formulations chosen by W. McLane on the basis of his laboratory results. The following report summarizes the results of the spray tests with the various bead formulations and with various choices of nozzle assemblies.

METHODOLOGY

Equipment: An APHIS Cessna Agtruck with a conventional boom assembly was used to deliver the formulations. Each test (Table 1) utilized two nozzles per wing. The nozzles are described in Table 1. The formulation mixtures were passed through a window screen to eliminate any large particles before they were added to the hopper. The following are the nozzles and valves evaluated: Conventional No. 8004, 8010, 8020, and 8030 flat-fan nozzles, new red CP plastic nozzles (C&E Enterprises, Mesa, AZ), 1.5" and 12" x 1.4" OD stainless steel pipe nozzles, 4" x 1.4" OD copper pipe nozzles (made by T. Roland, APHIS, Mission, TX), and CP check valves, (stainless steel CP bodies with plunger; C&E Enterprises, Mesa, AZ).

Formulations: The following adjuvants were used with water (v/v) to prepare the tank mixes: Bond (carboxylated synthetic latex; Loveland Industries, Inc., Greeley, CO) adhesive and Nalquatic (30% polycarboxylate polymer; Nalco Chemical Co., Naperville, IL) and StaPut (acrylamide polymer; Nalco Chemical Co., Naperville, IL) thickening agents. AgriSense beads were added at a rate of 75 g beads (30.4% a.i.) per gallon.

Test Design: Forty 4" x 5" Kromekote (red) spray cards were placed on stands at 5-foot intervals along a 200-foot line. Each test consisted of the spray from a single pass of the aircraft at 50-foot elevation over the cards. The number of beads per card was counted under a binocular microscope and the number of beads in each cluster on the cards was also recorded. The accompanying graphs show the bead distributions. The nozzles were examined at the end of each test to look for buildup of beads. Each of the nozzles tested delivered formulation at an approximate rate of 2.5 gal/min at 40 psi. A pressure of 52 psi was used in Tests 3-15 so that the four nozzles would deliver a total of approximately 18.2 gal/min. Since the aircraft flying at 120 mph with a 75 foot-wide swath covers 18.18 acres/min, this spray rate delivers approximately one gal/acre. In Tests 17-22, the pressure was set at 40 psi to conserve material; therefore, less material was delivered. Test 16 was not completed.

RESULTS

Nozzle and Formulation Performance

The following is a comparison of the test results with respect to the nozzle variations and

the total beads deposited on spray cards. (The deposit of single vs clusters of deposited beads will be discussed in the next section.)

The initial tests were conducted with a tank mix of 0.75% Nalquatic and 2% Bond and with conventional flat-fan nozzles on the aircraft. No. 8010, 8020, and 8030 nozzles resulted in buildup at the diaphragm which generally leads to incomplete shut-off and drooling in the turns. No. 8004 nozzles completely plugged since the orifice was too small. Therefore, other nozzle systems were explored.

Tests 3, 4, 5, and 6 utilized the red CP plastic nozzles and compared the position of the big hole on the nozzle when mounted in the CP check valve body; these tests used the tank mix made the previous day with 0.75% Nalquatic and 2% Bond. Although this tank mix had been passed through a small ground spray rig in the hanger for several hours in nozzle tests, it was deemed acceptable for use in comparing the nozzle positions. The best bead distribution on the spray cards seemed to result when the big hole was pointed aft and this was then the hole position used for all subsequent tests with the red CP plastic nozzles.

Test 7 showed that the 12" SS pipes, when attached to CP check valve bodies, plugged with beads and very few beads were found on the spray cards. Tests 8 and 9 were duplicate runs with 1.5" SS pipes mounted (45° forward) on CP check valve bodies. Some buildup occurred, and the numbers of beads found on the cards were less than those found in subsequent Tests 19 and 22 when the same 1.5" pipes were pointed aft on the CP check valve bodies. Therefore, the combination of 1.5" pipe nozzles pointed aft and CP check valve body is preferred; positive shut-off was achieved.

Tests 10, 11, and 12 compared nozzles for delivery of a freshly prepared tank mix of 10% StaPut and 2% Bond. The red CP plastic nozzles, pointed down with the hole aft as in Test 5, were compared with both 90° (Test 10) and 45° (Test 11) splash-plate settings. The 90° setting gave a more uniform distribution of beads over 7 cards (#14-20) for a 30-foot swath. The 45° setting seemed to spread the beads over a wider swath (Cards #15-25; 50 ft) but less uniformly. Test 12 used 4" x 1/4" OD copper pipe nozzles mounted directly on the boom with no shut-off valves. Large quantities of beads were found across two 10-foot swaths (i.e., 3 cards each) separated by 50 ft (center to center). This system would be ideal for treating rows of trees; the spacing between the swaths could be altered by changing the position of the nozzles on the boom. These nozzles might also work well for the gypsy moth beads if more nozzles were added to eliminate the middle gap and if a workable shut-off mechanism was added to eliminate spillage from the open tubes.

These last three tests were repeated using the same tank mix after additional StaPut was added to bring its concentration to 50% (Tests 13, 14 and 15). Tests 14 and 15 compared the 90° and 45° positions, respectively, on the splash plate; the 90° setting again proved to be a more effective position, delivering much higher numbers of beads on the spray cards and in a more uniform pattern than did the 45° position. The 4" copper pipe nozzles with no shut-off valves (Test 13) again gave two 15 foot-wide swaths separated by 50 ft (center to center). Far less beads were found on the spray cards of Test 13 with the 50% StaPut than with the 10% (Test 12) but this large difference was not apparent with the red CP plastic nozzles (Tests 11 and 12 vs Tests 14 and 15).

The remaining six tests compared 3 nozzles for delivery of 0.25% Nalquatic (Tests 17, 18 and 19) and 0.75% Nalquatic (Tests 20, 21 and 22). The red CP nozzles with 0.25% Nalquatic (Test 17) gave good dispersion of the beads but the total numbers of beads on the cards were low. When the Nalquatic concentration was increased to 0.75% (Test 20), the number of beads recovered on cards substantially increased. The 4" copper nozzles were again used in these tests but no significant difference was apparent for the 0.25% Nalquatic (Test 18) vs the 0.75% (Test 21). The two swaths of high bead deposition again resulted with a separation of 50 ft. The 1.5" SS pipe nozzles pointed aft and attached to the CP check valve bodies (Tests 19 and 22) operated far more efficiently than they had in Tests 8 and 9 when they were mounted 45° forward. Substantially more beads from the 0.25% Nalquatic were recovered on the spray cards with the 1.5" pipes of Test 19 than with the red CP plastic nozzles of Test 17. However, this difference was not apparent with 0.75% Nalquatic. It does appear that two nozzle variations, either the red or the 1.5" SS pipe nozzles could be used on the CP check valve bodies.

Bead Deposition

The patterns of bead deposition on the spray cards were not the same for all formulations and nozzle choices. Sprays which generated small droplets also deposited individual beads which often did not appear to be firmly attached to the spray cards. On the other hand, beads deposited in clusters appeared to be more tightly adhered to the cards since additional sticker increased coalescence of the cluster. It was also postulated that clustering of beads would slow the release of the disparlure since the relative amount of exposed surface area of beads in clusters is less than that as individuals.

Therefore, the ratios of single beads to clusters of four or more beads were examined for all of the spray tests. The following are general conclusions drawn from these comparisons and are illustrated on the attached graphs.

1. For the 0.75% Nalquatic formulation, variation of the hole position on the red CP plastic nozzles (Tests 3-6) did not significantly affect the ratio of singles to clusters. Also, the use of 1/4" pipe nozzles versus the red CP plastic nozzles also did not markedly affect the ratio (Tests 8 and 9 versus Test 5).

2. The 10% StaPut formulation (Tests 10-12) gave a relatively high ratio of clusters to single beads and this ratio was not significantly influenced by use of 90° (Test 10) versus 45° (Test 11) settings on the splash plate. The 4" pipe nozzles (Test 12) also gave a high ratio of clustered to single beads that was not markedly different from those with the red CP plastic nozzles.

3. The results of increasing the StaPut concentration to 50% were somewhat inconclusive (Tests 13-15). Comparisons of 50% versus 10% for given nozzles (i.e., Test 13 versus 12, Test 14 versus 10, and Test 15 versus 11) gave no indication that 50% yielded more beads or a higher ratio of clusters to singles than did 10% StaPut; in fact, the reverse was sometimes true. Therefore, only 10% (or possibly 20%) StaPut will be considered.

4. The 0.25% Nalquatic formulation (Tests 17-19) resulted in a high proportion of the beads being deposited as singles, particularly with the red CP plastic nozzles (Test 17). The use of pipe nozzles without (Test 18) or with (Test 19) CP check valves increased the number of clusters but not to the same level as with 10% StaPut. The droplet size on the spray cards with the red CP plastic nozzles and 0.25% Nalquatic was only about 1-4 mm diam. With the 1.5" pipes (Test 19), the droplet size was somewhat higher (2-5 mm diam.) but many droplets did not contain beads suggesting that the 0.25% Nalquatic was not adequate to give good bead suspension. This formulation, particularly with the red CP plastic nozzles (Test 17) would be very good to give a wide swath (see graph) of individual beads but the incomplete suspension of beads in the tank mix would probably result in operational problems.

5. An increase in the Nalquatic concentration to 0.75% (Tests 20-22) produced relatively high ratios of clusters to single beads for the 3 nozzle types. The average droplet size from the red CP plastic nozzles (Test 20) was about 5-6 mm and was thus significantly larger than the 1-4 mm which occurred with 0.25% Nalquatic. However, it was observed that a large number of beads in Test 20 apparently had "rolled" a few mm away from their originally deposited locations and were thus out of their "glue"; this may have been due to inadequate dry time in the field before the cards were transported. The beads deposited from the 4" pipes with no shut-off valves (Test 21) were primarily in large "splats" rather than individual droplets as occurred with the 10% StaPut (Test 10). The 1.5" pipe nozzles on the CP check valve bodies (Test 22) did not increase the ratio of clustered to single beads as compared to the red CP plastic nozzles (Test 20). It appears the ratio of clusters to individual beads is a function of the formulation and is relatively independent of nozzle type.

6. The comparison of 0.75% Nalquatic (Tests 20 and 21) versus the 10% StaPut formulations (Tests 10 and 12), each with the red CP plastic nozzles (Tests 20 and 10) and the 4" pipes with no shut-off (Tests 21 and 12), gave no clear conclusions. The proportion of clusters versus single beads is similar for both formulations. The spray pattern in Test 10 (10% StaPut) appeared to be more uniform but the data are an average of 2 passes by the aircraft. The number of beads is higher with the red CP plastic nozzles and 0.75% of Nalquatic (Test 20) than with 10% StaPut (Test 10) but the reverse is true with the pipe nozzles.

CONCLUSIONS

The spray tests successfully demonstrated that the AgriSense beads containing disparlure can be applied by conventional aircraft spray systems using special nozzles. Either 10% (or higher) StaPut or 0.75% Nalquatic, each with 2% Bond, provides a sprayable formulation. The degree of clustering of beads appears to be similar for both formulations and seems independent of nozzle selection. The choice between the two thickening agents (Nalquatic or StaPut) for use in the Forest Service spray tests will be made on the basis of both wash-off tests (by W. McLane) and chemical evaluation of stability and release rate (by B. Leonhardt).

With respect to nozzle/valve selection, conventional No. 8004 flat-fan nozzles readily plugged with beads and No. 8010, 8020, and 8030 flat-fan nozzles gave bead buildup at the diaphragms. CP check valve bodies gave more positive shut-off than did the standard spray nozzle bodies with diaphragms. Red CP plastic nozzles or short (1.5") pipe nozzles when attached to the CP check valve bodies worked well when pointed aft; the best position for the red

CP plastic nozzles was with the big hole pointed aft and a 90° setting on the splash plate. The 4" copper pipe nozzles attached directly to the boom also worked very well and could be the nozzle of choice if a yet-to-be tested flap provides sufficient shut-off. The choice of nozzles for the cooperative FS test in Virginia will be made by the Gypsy Moth Mating Disruption Committee meeting (March 11) following consideration of the recommendations by Win McLane.

Table 1: Summary of Tests

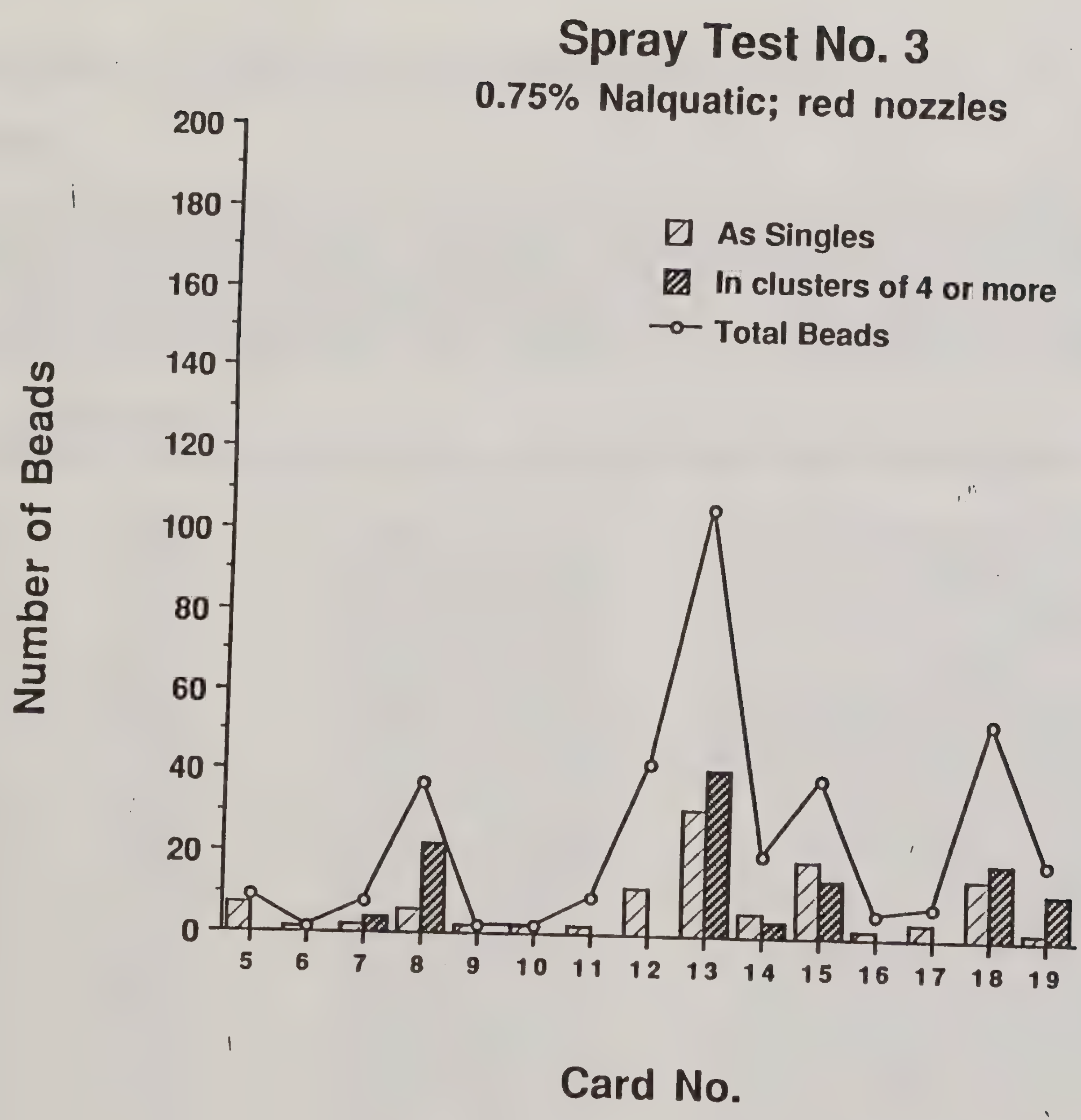
Test No.	Spray Date	Tank Mix[1]	Nozzles[2] (positioned): 2 per Wing
3	1/23	2%Bond; 0.75% NQ[3]	Red CP nozzles (aft); big hole under nozzle & 90° splash plate
4	1/23	2%Bond; 0.75% NQ[3]	Red CP nozzles (down); big hold forward & 90° splash plate
5	1/23	2%Bond; 0.75% NQ[3]	Red CP nozzles (down); big hole aft & 90° splash plate
6	1/23	2%Bond; 0.75% NQ[3]	Red CP nozzles(aft); big hole on top of nozzle & 90° splash plate
7	1/23	2%Bond; 0.75% NQ[3]	12" x 1/4" OD Cu pipes (down) on CP check valve bodies
8	1/23	2%Bond; 0.75% NQ[3]	1.5" x 1/4" OD SS pipes (45° forward) on CP check valve bodies
9	1/23	2%Bond; 0.75% NQ[3]	1.5" x 1/4" OD SS pipes (45° forward) on CP check valve bodies
10[4]	1/24	2%Bond; 10% StaPut	Red CP nozzles (down); big hole aft & 90° splash plate
11	1/24	2%Bond; 10% StaPut	Red CP nozzles (down); big hole aft & 45° splash plate
12	1/24	2%Bond; 10% StaPut	4" x 1/4" OD Cu pipes (aft); no valves
13	1/24	2%Bond; 50% StaPut	4" x 1/4" OD Cu pipes (aft); no valves
14	1/24	2%Bond; 50% StaPut	Red CP nozzles (down); big hole aft & 90° splash plate
15	1/24	2%Bond; 50% StaPut	Red CP nozzles (down); big hole aft & 45° splash plate
17	1/25	2%Bond; 0.25% NQ[3]	Red CP nozzles (down); big hole aft & 90° splash plate
18	1/25	2%Bond; 0.25% NQ[3]	4" x 1/4" OD Cu pipes (aft); no valves
19	1/25	2%Bond; 0.25% NQ[3]	1.5" x 1/4" OD SS pipes (aft) on CP check valve bodies
20	1/25	2%Bond; 0.75% NQ[3]	Red CP nozzles (down); big hole aft & 90° splash plate
21	1/25	2%Bond; 0.75% NQ[3]	4" x 1/4" OD Cu pipes (aft); no valve
22	1/25	2%Bond; 0.75% NQ[3]	1.5" x 1/4" OD SS pipes (aft) on CP check valve bodies

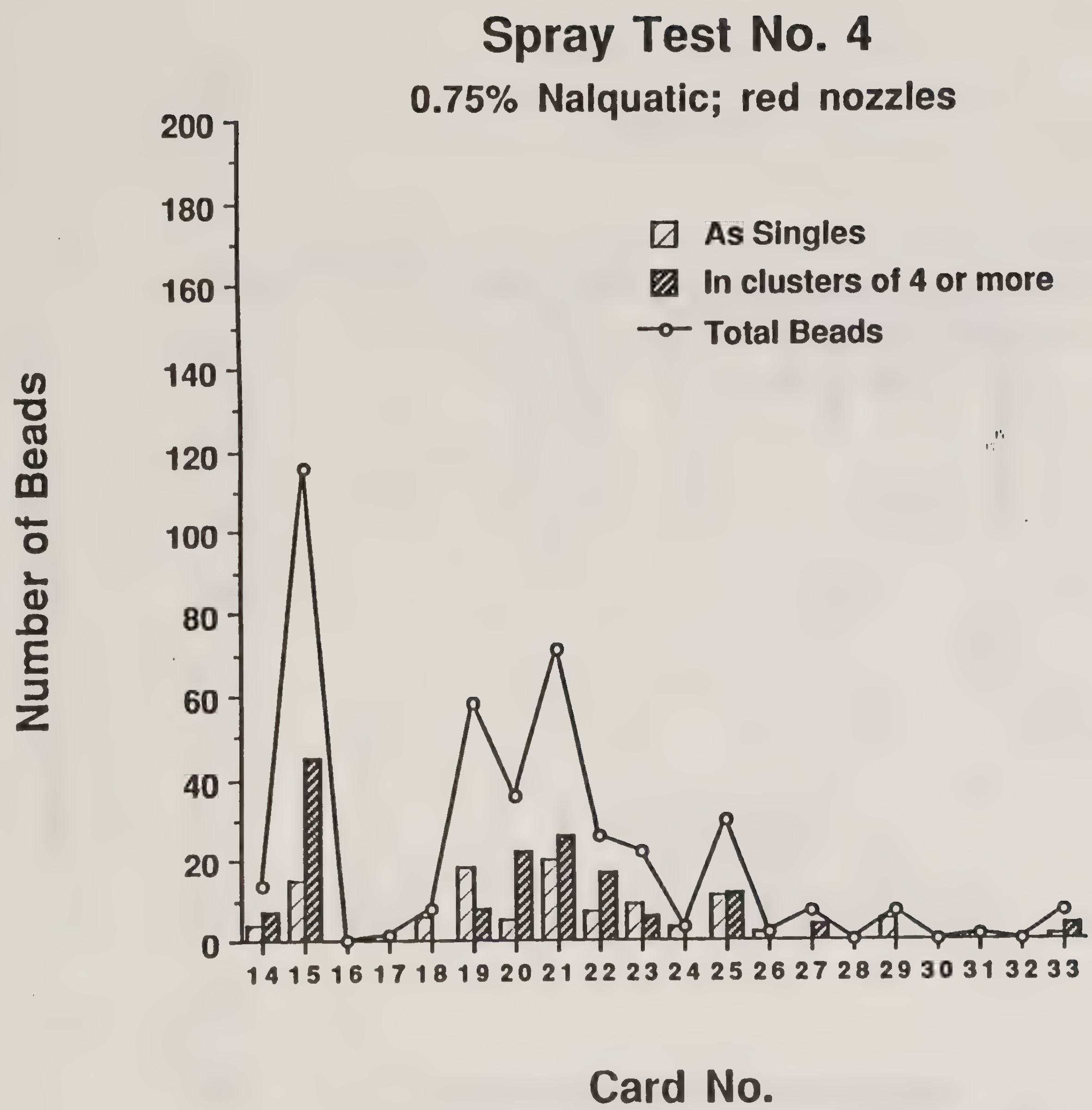
1 All tank mixes (v/v), with the exception of tests 13, 14 and 15, contained 75 g beads/gal; tests 13, 14, and 15 contained about one-half of that quantity.

2 All mixing was done in the aircraft hopper; beads were pre-mixed prior to being added to the hopper. The mixing order was: water, thickener, beads, and sticker. Red CP nozzles = red plastic nozzles with check valve bodies. All nozzles were connected directly into the spray boom with no shut-off between the nozzle body and the boom. Runs 3-15 were applied using 52 psi and runs 17-22 with 40 psi (run 16 was not completed). 45° forward = nozzle orfice pointing 45° into slip stream when spraying; down = nozzle orfice pointing straight down when spraying; aft = nozzle orfice pointing straight aft of aircraft when spraying.

3 NQ = Nalquatic

4 Cards were sprayed on 2 passes; therefore, bead quantities were divided by 2.

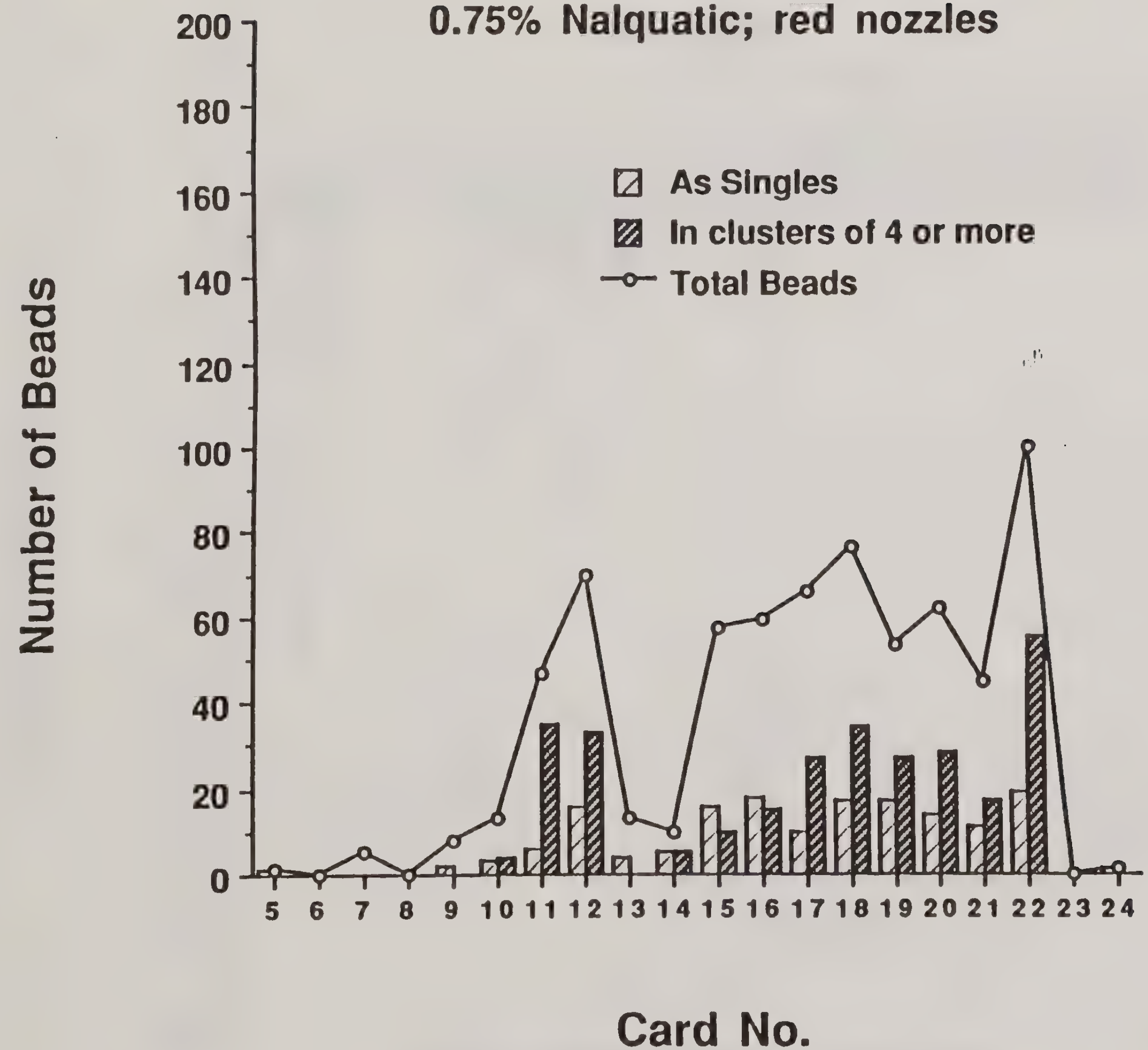

Spray Test No. 3
0.75% Nalquatic; red nozzles
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
200
180
160
140
120
100
80
60
40
20
0
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
Card No.



Spray Test No. 4
0.75% Nalquatic; red nozzles
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
0
20
40
60
80
100
120
140
160
180
200
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
Card No.

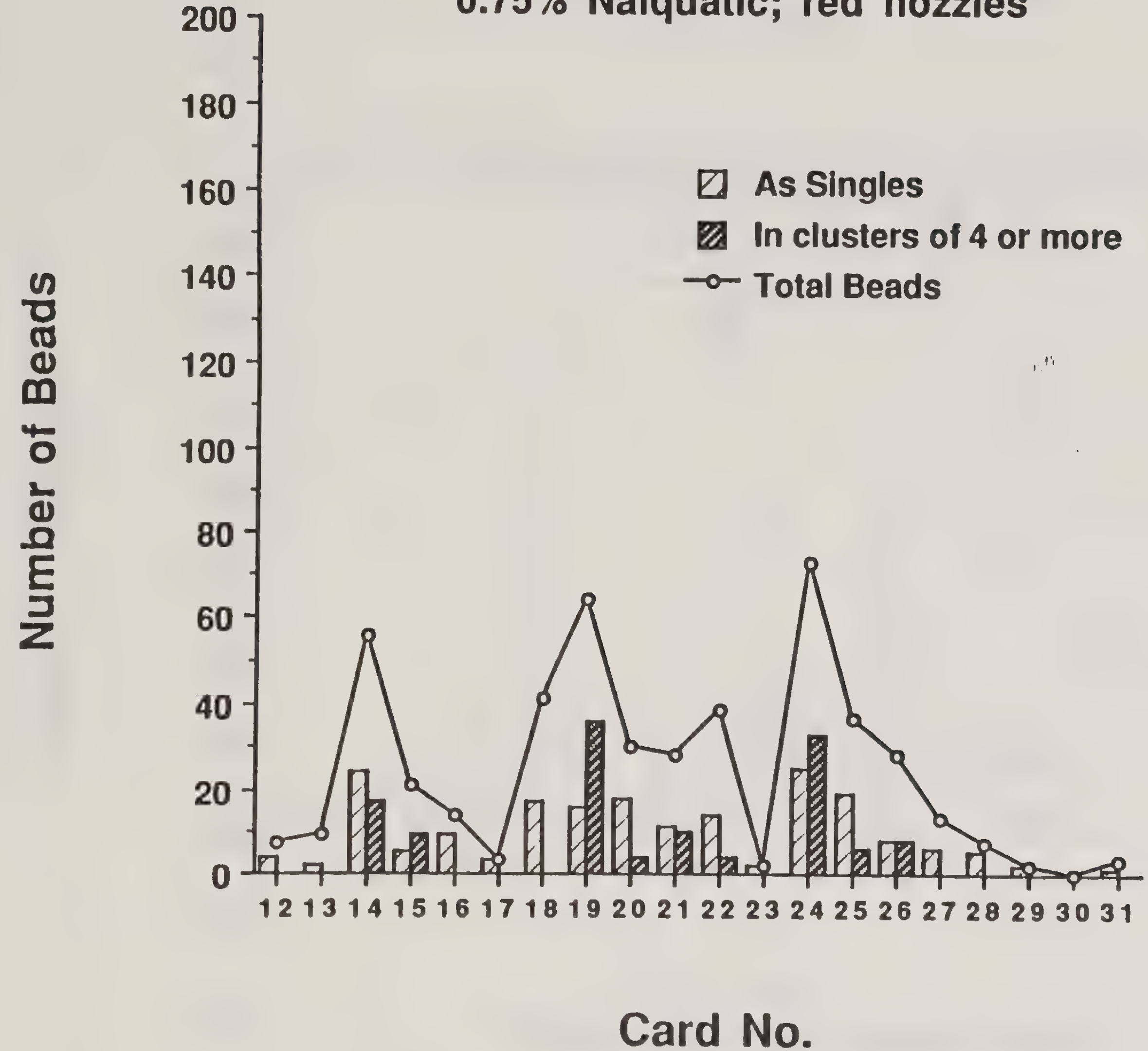
Spray Test No. 5

0.75% Nalquatic; red nozzles



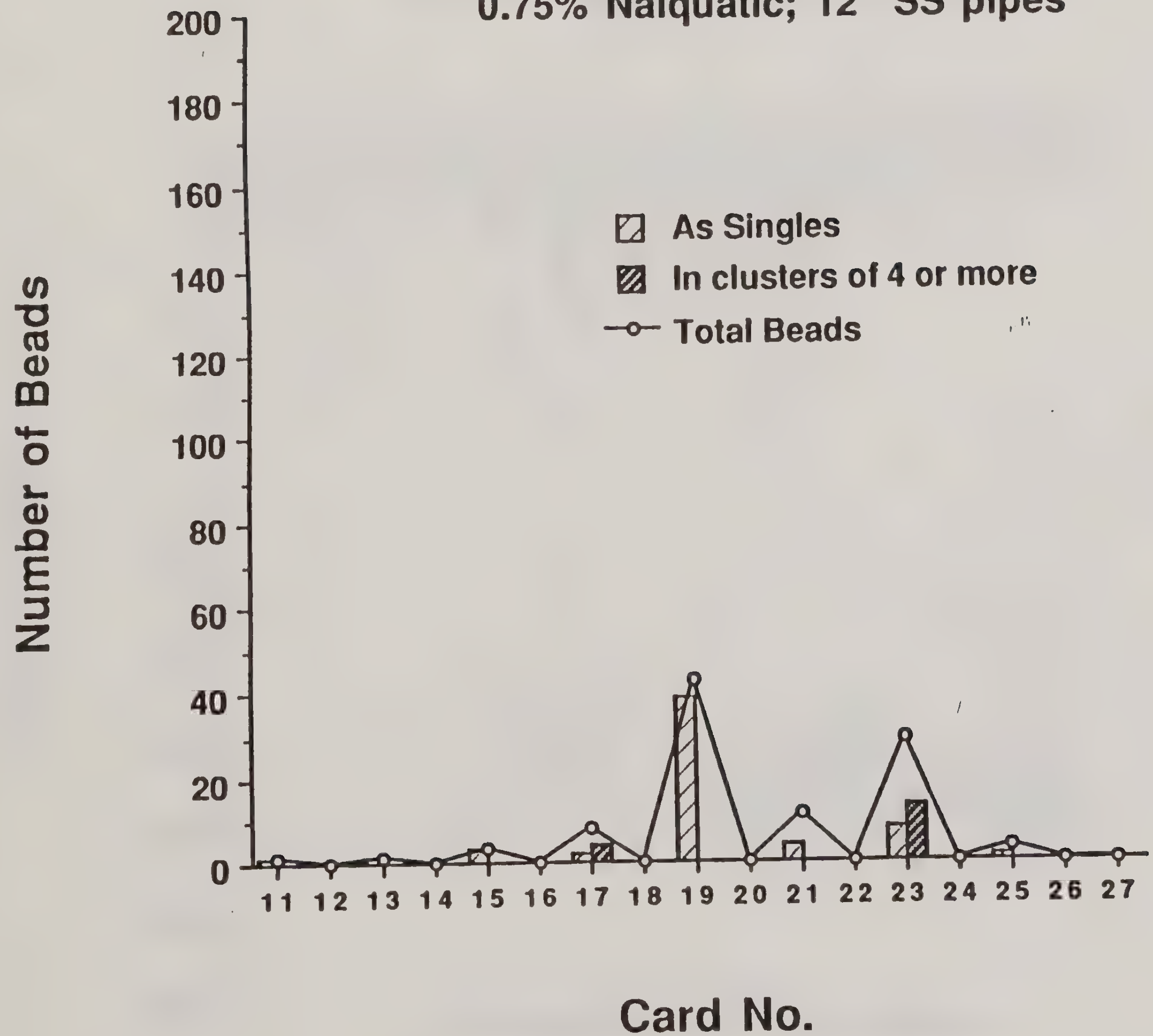
Spray Test No. 6

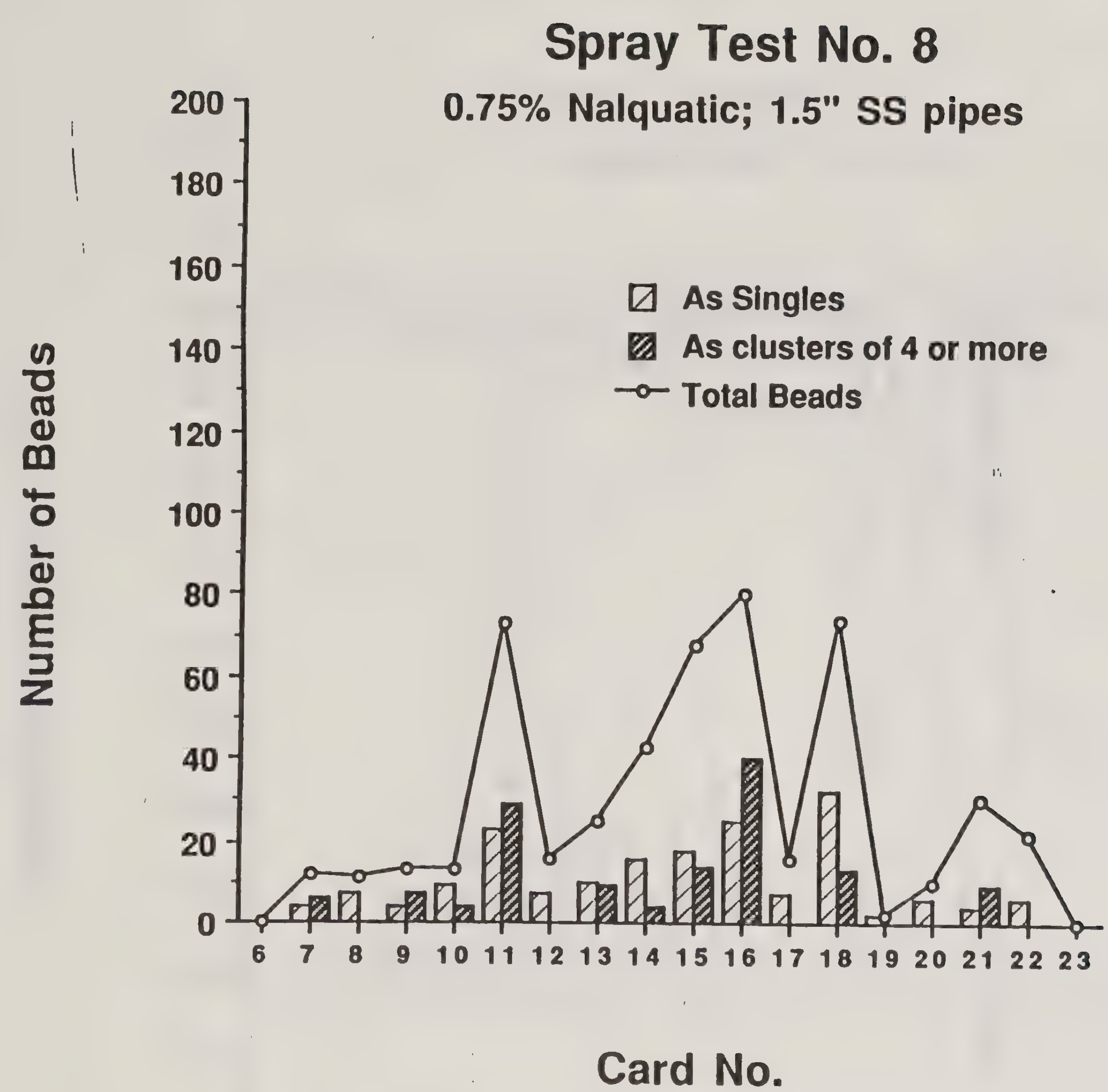
0.75% Nalquatic; red nozzles



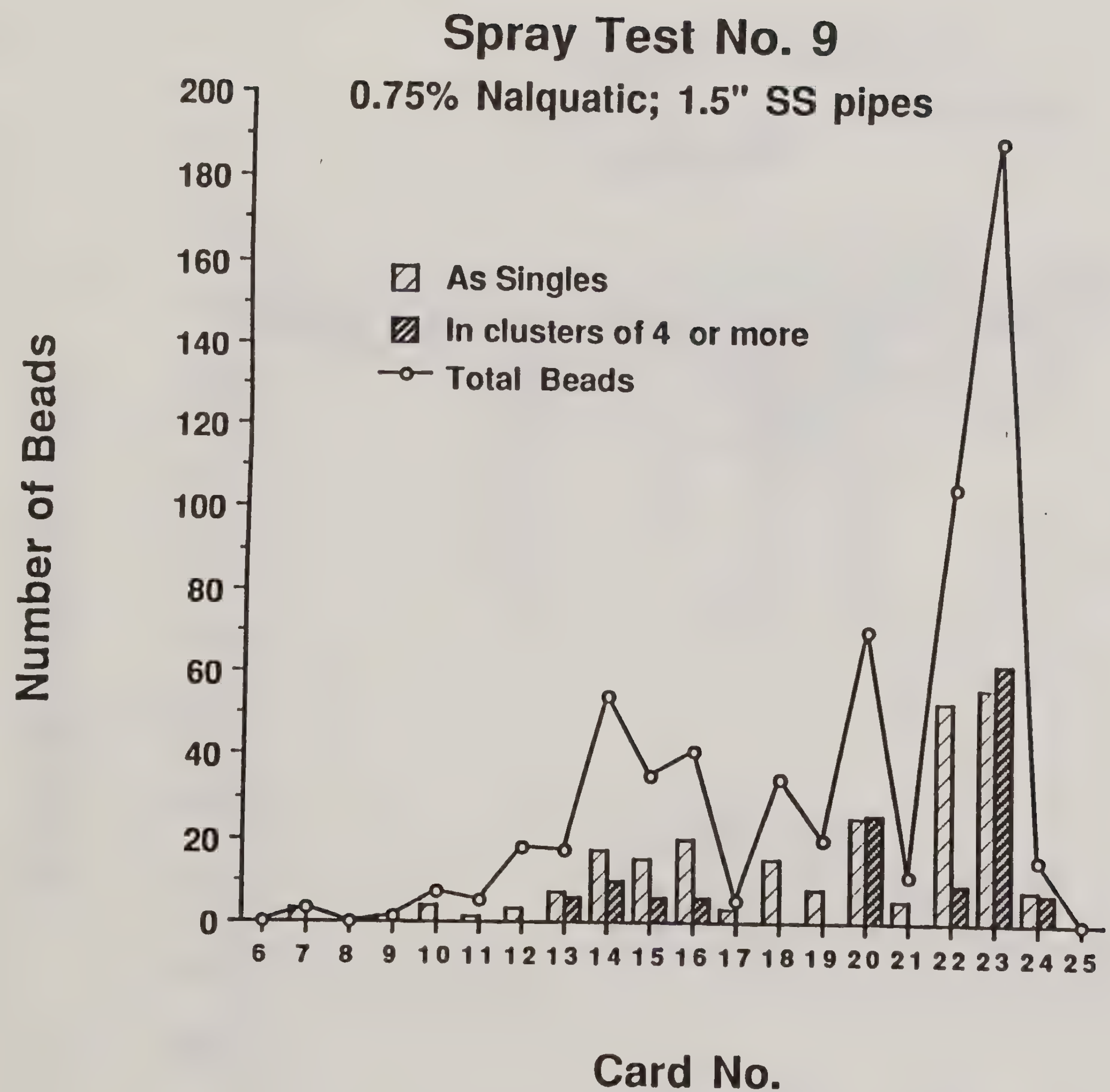
Spray Test No. 7

0.75% Nalquatic; 12" SS pipes

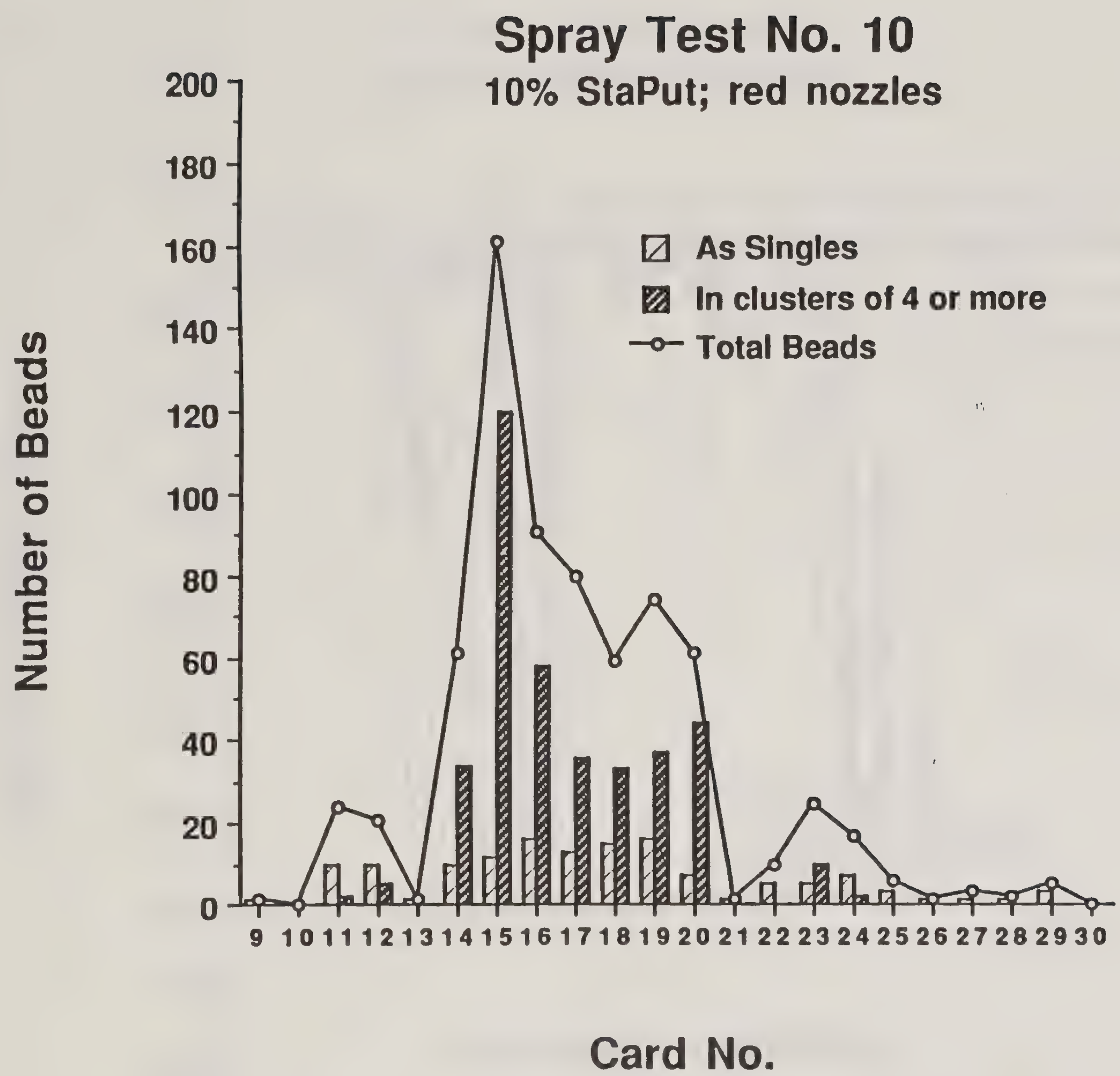


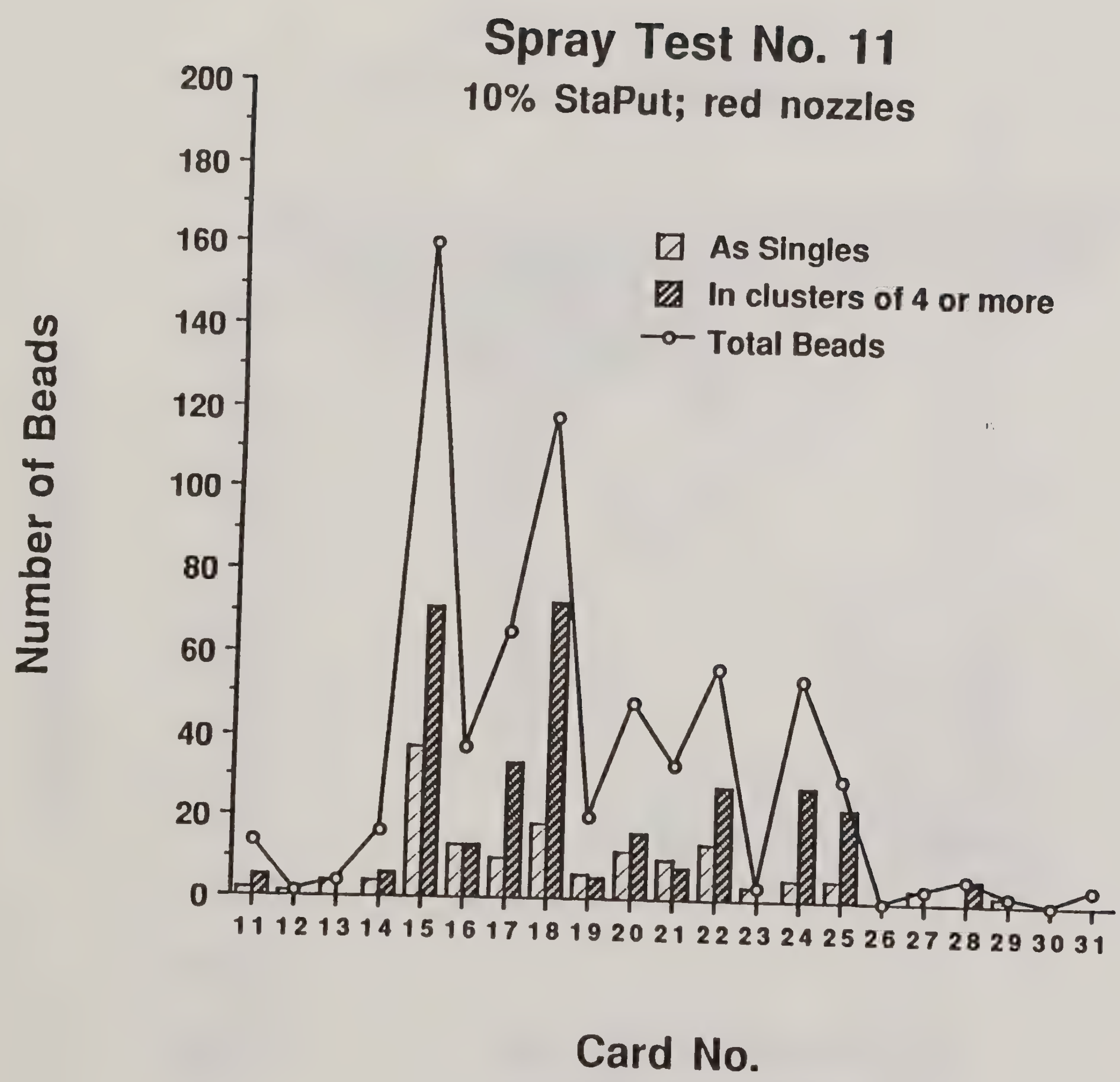


Spray Test No. 8
0.75% Nalquatic; 1.5" SS pipes
As Singles
As clusters of 4 or more
Total Beads
Number of Beads
0
20
40
60
80
100
120
140
160
180
200
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Card No.



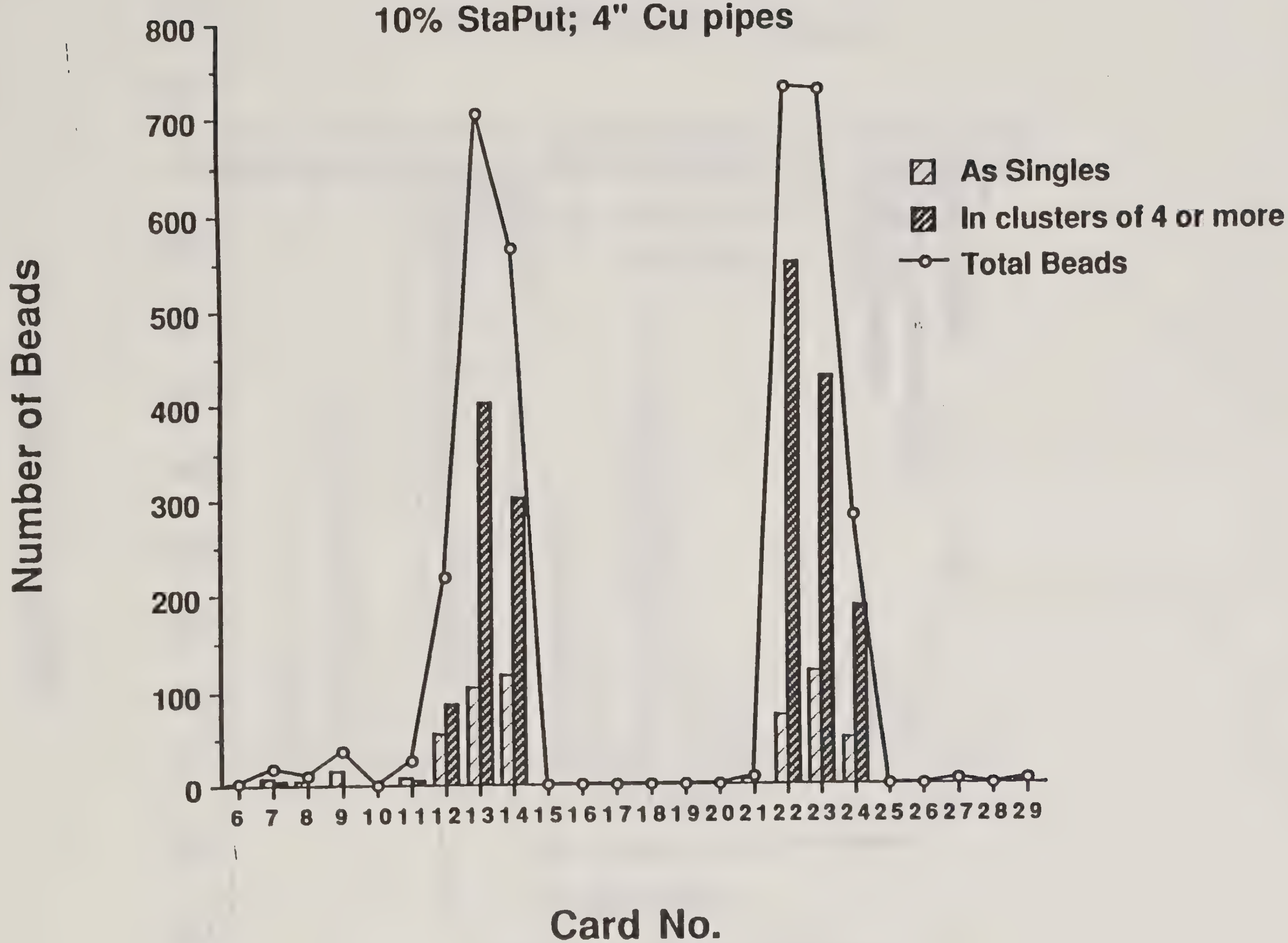
Spray Test No. 9
0.75% Nalquatic; 1.5" SS pipes
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
0
20
40
60
80
100
120
140
160
180
200
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Card No.

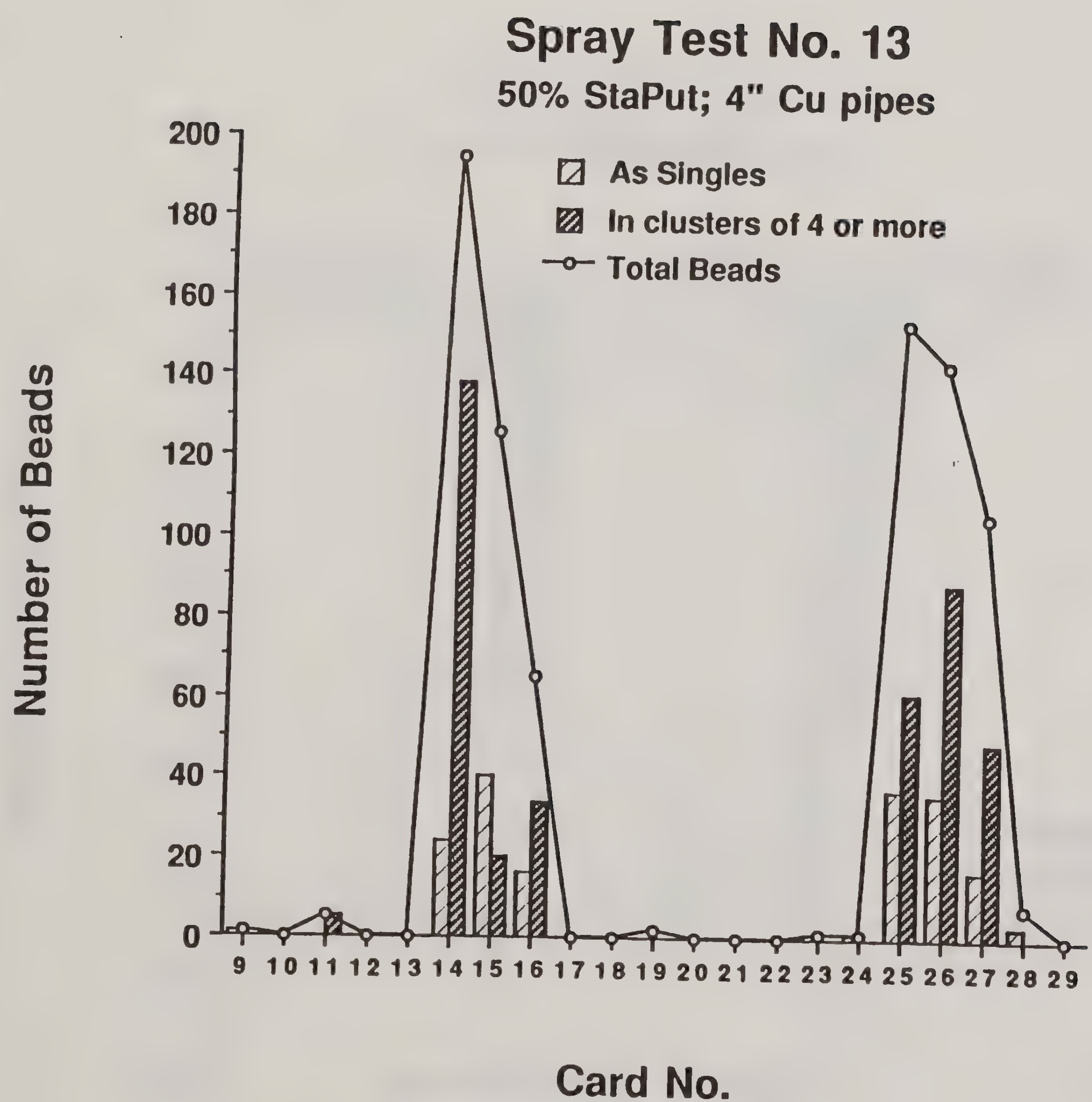

Spray Test No. 10
10% StaPut; red nozzles
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
200
180
160
140
120
100
80
60
40
20
0
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Card No.


Spray Test No. 11
10% StaPut; red nozzles
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
0
20
40
60
80
100
120
140
160
180
200
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Card No.

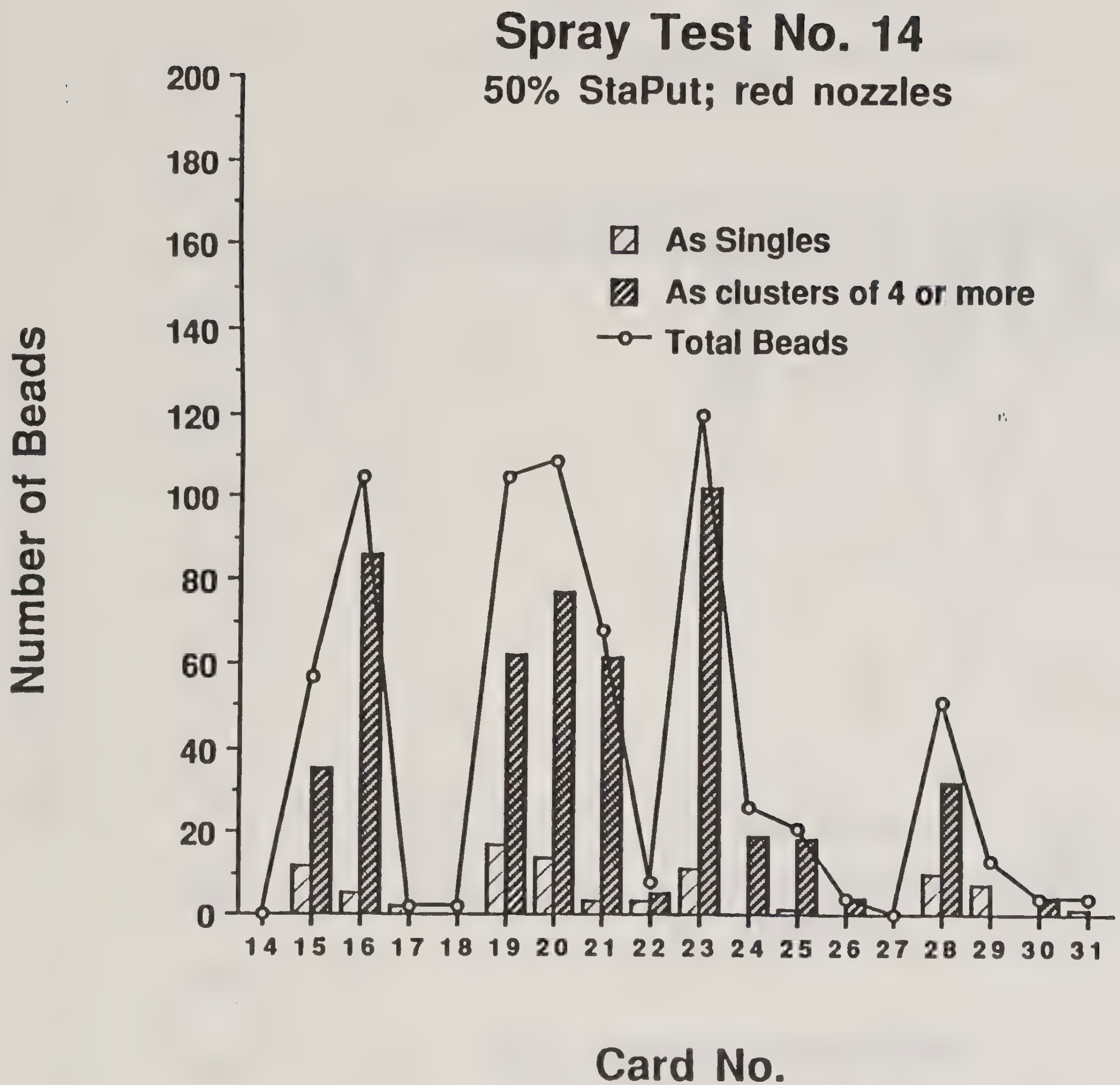
Spray Test No. 12

10% StaPut; 4" Cu pipes

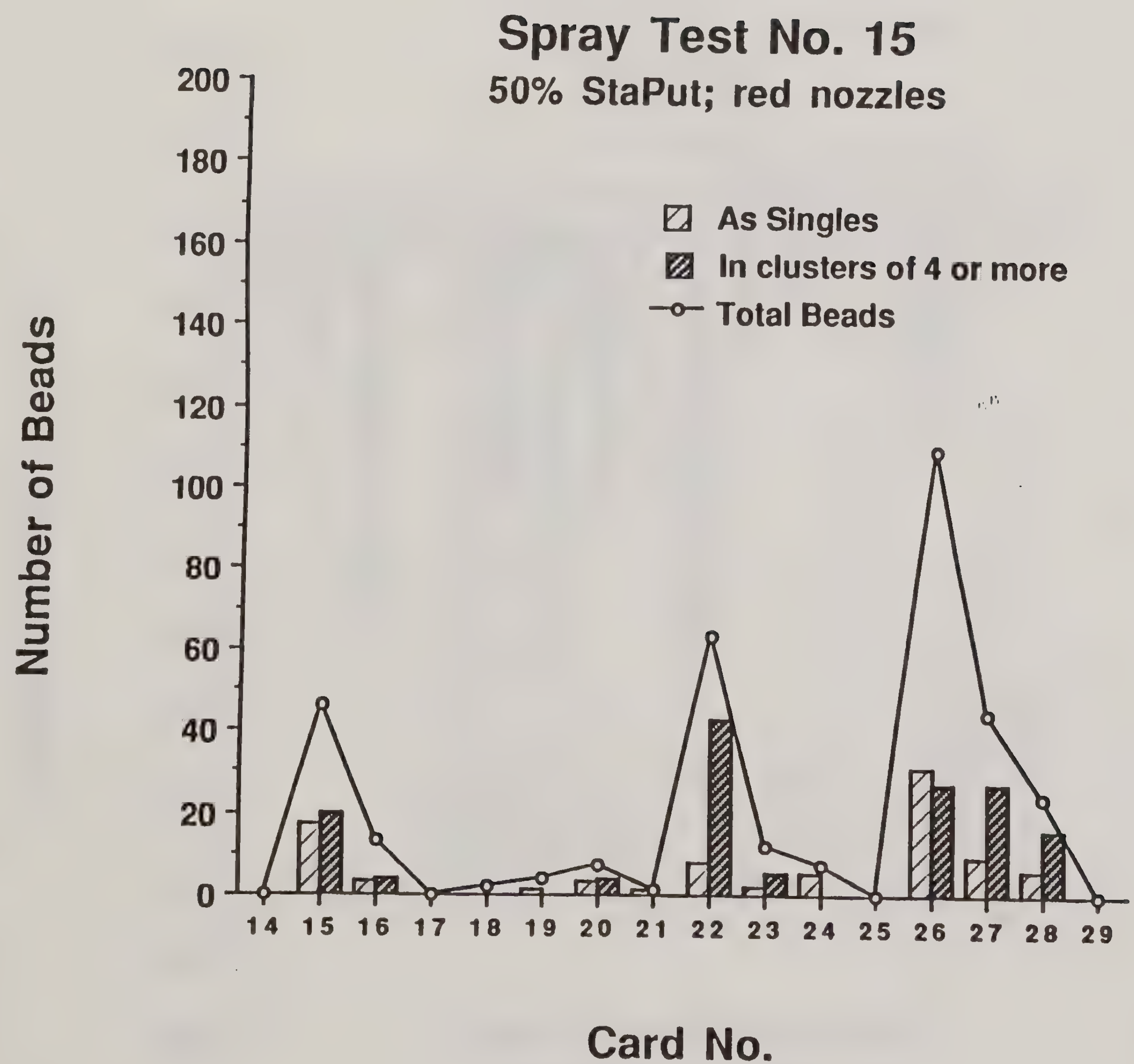




Spray Test No. 13
50% StaPut; 4" Cu pipes
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
0
20
40
60
80
100
120
140
160
180
200
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
Card No.

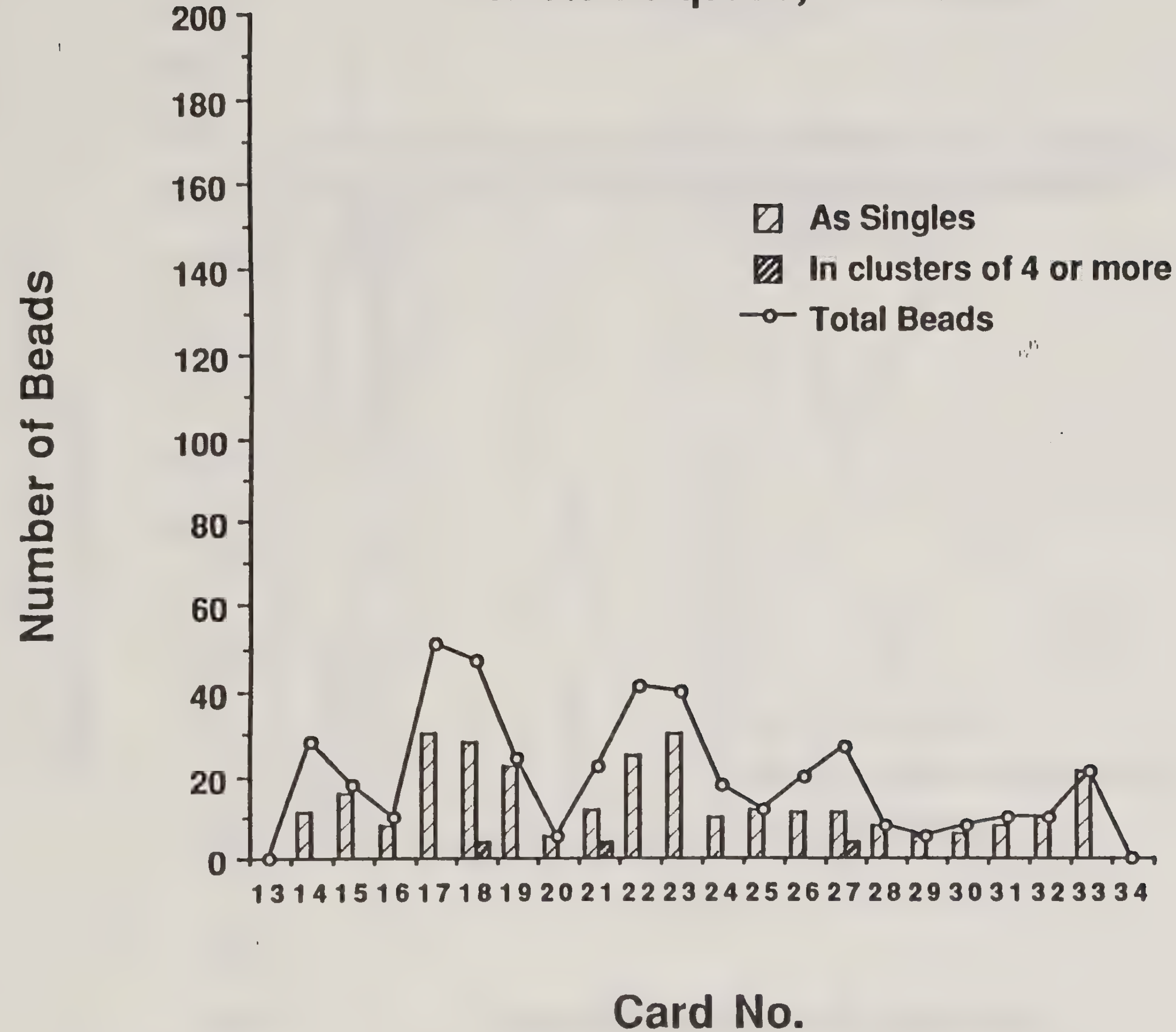


Spray Test No. 14
50% StaPut; red nozzles
As Singles
As clusters of 4 or more
Total Beads
Number of Beads
200
180
160
140
120
100
80
60
40
20
0
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Card No.

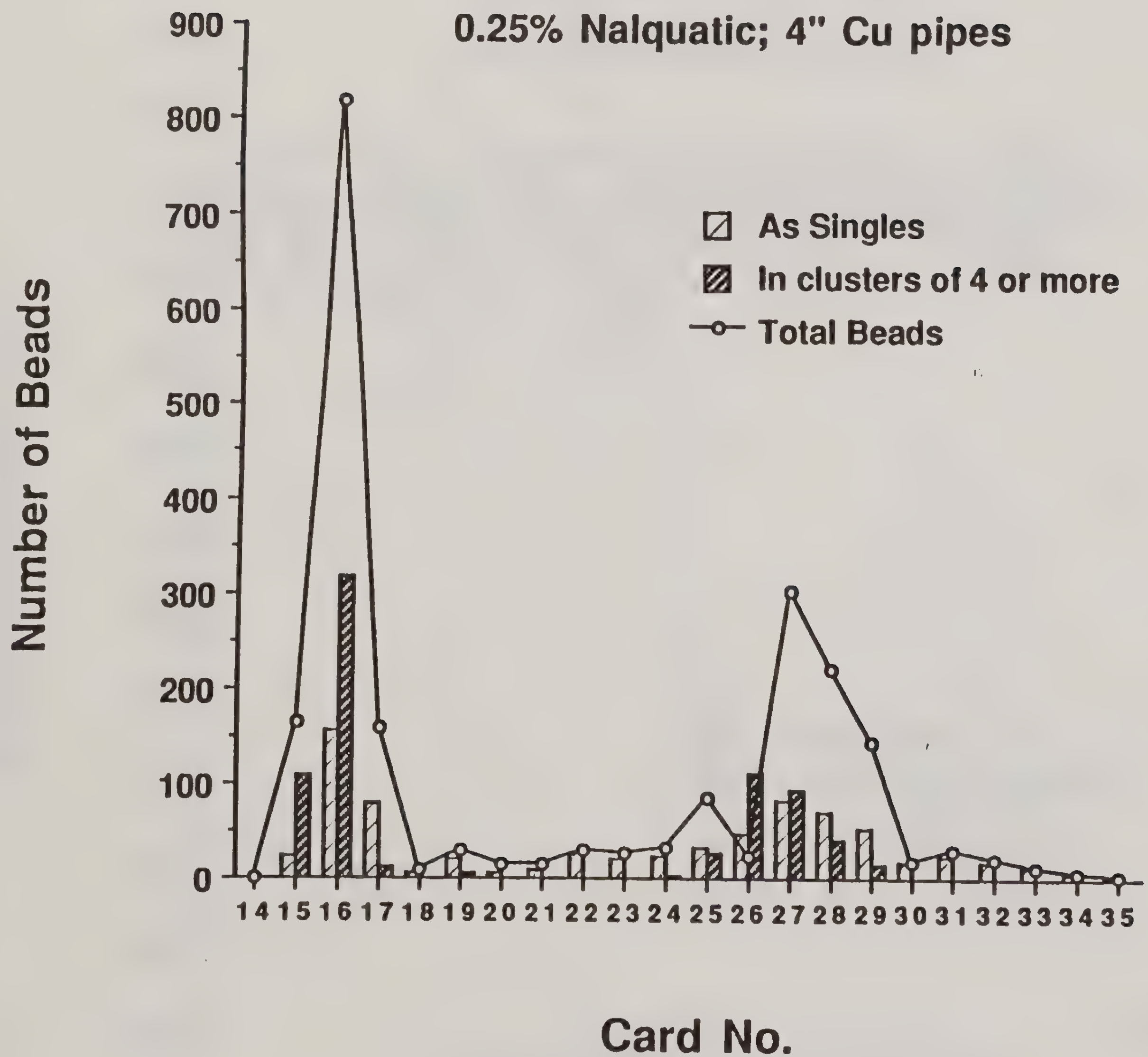

Spray Test No. 15
50% StaPut; red nozzles
Number of Beads
200
180
160
140
120
100
80
60
40
20
0
As Singles
In clusters of 4 or more
Total Beads
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
Card No.

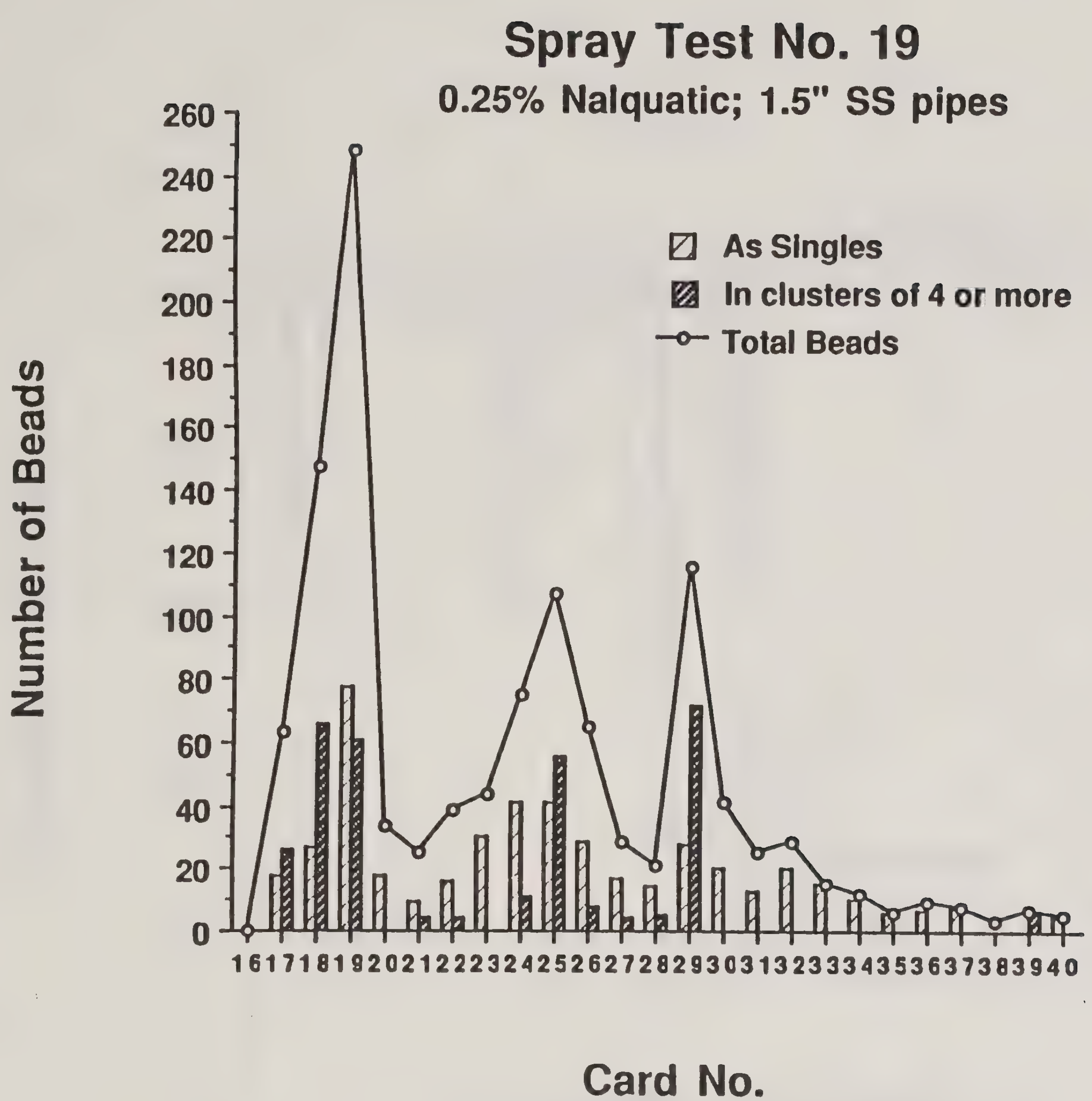
Spray Test No. 17

0.25% Nalquatic; red nozzles

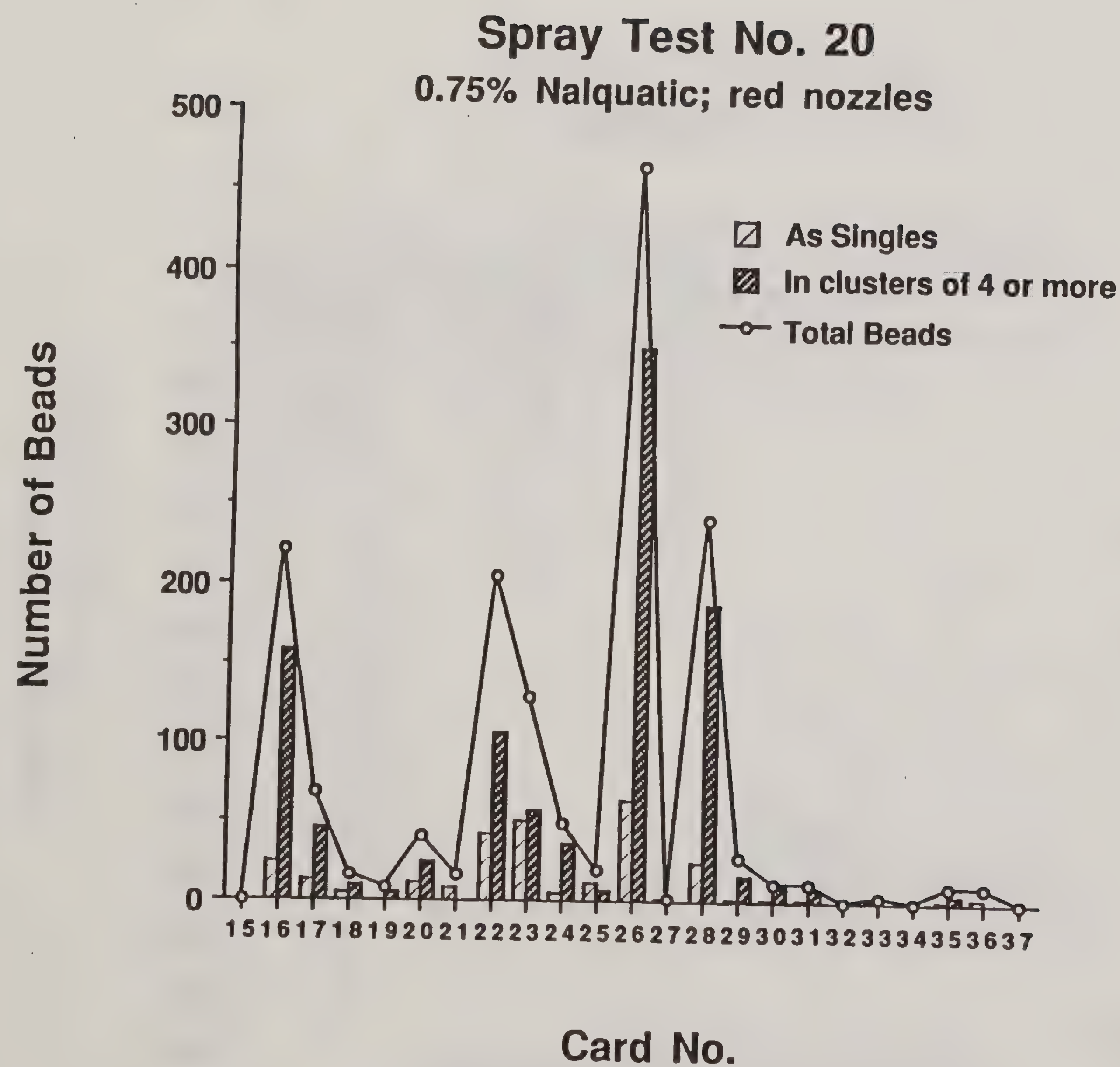


Spray Test No. 18



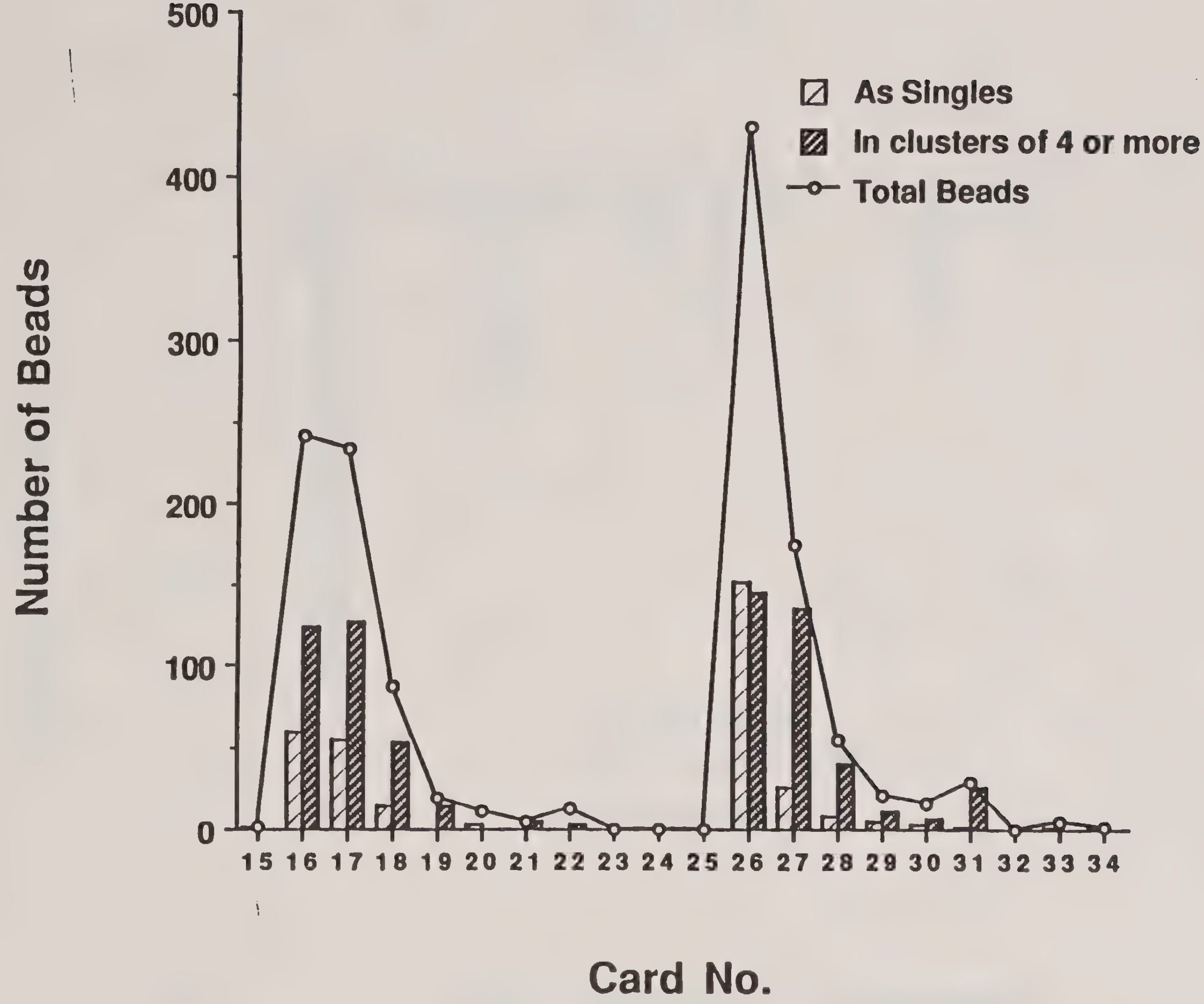


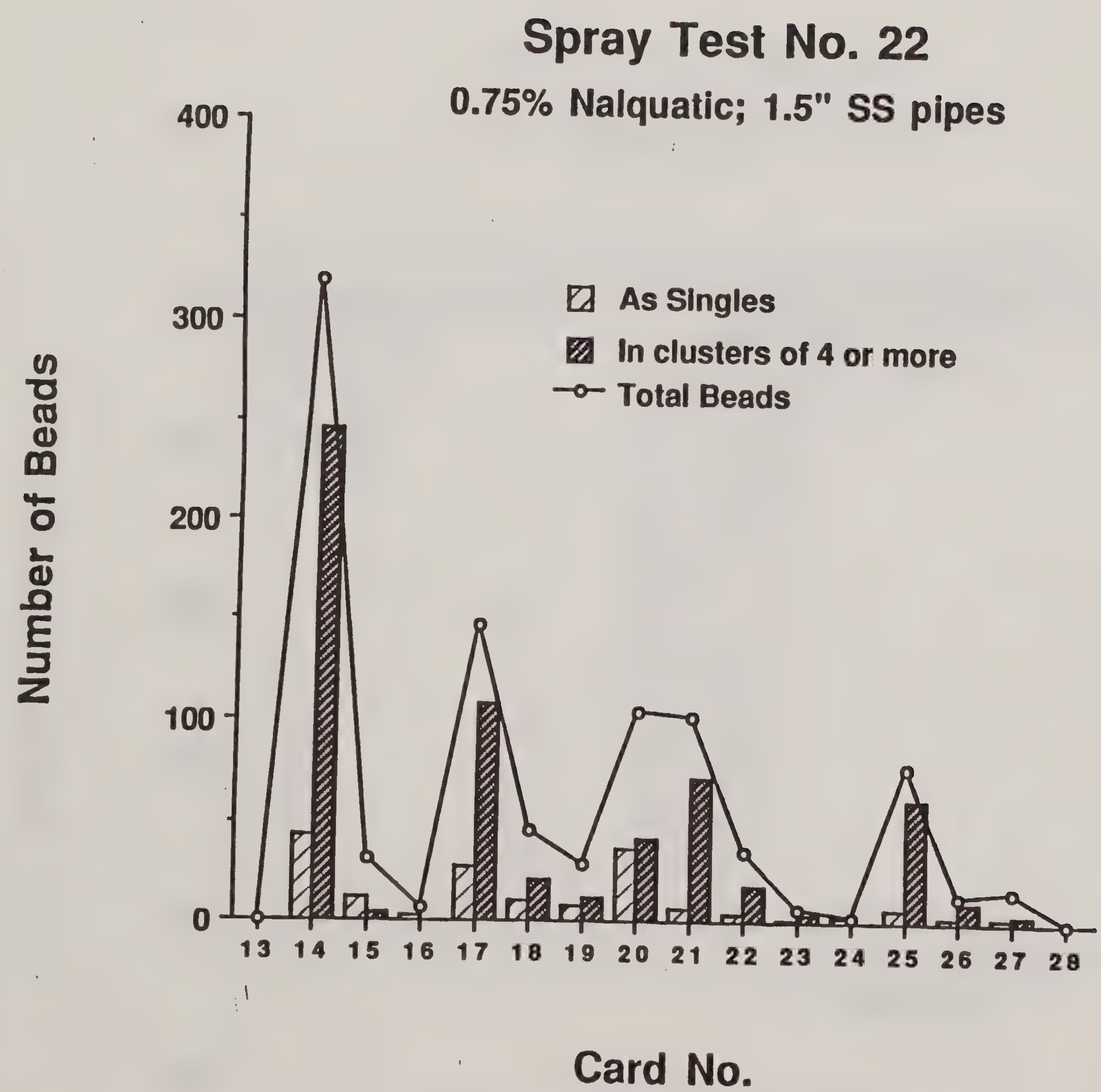
Spray Test No. 19
0.25% Nalquatic; 1.5" SS pipes
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
260
240
220
200
180
160
140
120
100
80
60
40
20
0
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Card No.


Spray Test No. 20
0.75% Nalquatic; red nozzles
Number of Beads
500
400
300
200
100
0
As Singles
In clusters of 4 or more
Total Beads
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
Card No.

Spray Test No. 21

0.75% Nalquatic; 4" Cu pipes





Spray Test No. 22
0.75% Nalquatic; 1.5" SS pipes
As Singles
In clusters of 4 or more
Total Beads
Number of Beads
0
100
200
300
400
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
Card No.

Dick Reardon
September 1991

1991 - AIPM Sponsored Field Projects

Richard Reardon
9/10-11/91

1. A Comparison of Aerially Applied US and Canadian Standard Formulations of Gypchek

   - potentially defoliating (greater than 500EM/A) population of gypsy moth

   - study areas established in Canada and US via a coop agreement with Dr. Cunningham (FPMI)

   - six 30-acre plots per treatment for 4 treatments: (1) US standard, 2 appl; (2) US standard, 1 appl; (3) Canadian standard, 2 appl (i.e. lower dose and volume than US standard); and (4) untreated checks

   - egg mass counts not available for Canadian plots, for US plots: all controls increased and % corrected population reduction was approximately 80, 82, and 81% respectively.

2. Aerial Application of Bt: A Comparison of Efficacy Results When Applied Against 1st and 2nd vs 3rd and 4th Stage Larvae

   - potentially defoliating (greater than 500EM/A) population of gypsy moth

   - study areas established on George Washington National Forest

   - six 50-acre plots per treatment for 5 treatments: (1) undiluted Foray 48B at 24BIU/acre against 1st and 2nd, (2) undiluted Foray 48B at 36 BIU/acre against 3rd and 4th, (3) Thuricide 48LV at 24 BIU against 1st and 2nd, (4) Thuricide 48LV at 40 BIU/acre against 3rd and 4th and (5) untreated checks

   - egg mass counts not available at this time

3. Aerial Application of Racemic Disparlure Impregnated Hercon Flakes and AgriSense Beads to Suppress Low Density Populations of Gypsy Moth

   - 3 reps/treatment, single and double application, populations less than 20 egg masses/A

   - results not available at this time (McLane - to present preliminary results)

4. Aerial Application of Sterile Eggs and Ground Release of Sub-Sterile Pupae to Suppress Low Density Populations of Gypsy Moth

   - 3 reps/treatment, single and double applications, populations less than 20 egg masses/A

   - results not available at this time (McLane - to present preliminary results)

5. Pilot Project to Evaluate the 4L and 25W Formulations of Dimilin

- potentially defoliating populations (greater than 500 EM/A) of the gypsy moth

- 3 reps per treatment for 5 treatments: (1) 25W at 2 oz, (2) 25W at 1 oz, (3) 4L at 2 oz, (4) 4L at 1 oz, and (5) untreated checks.

- results not available at this time

Dick Reardon

Dimilin Bibliography Program

A Dimilin database is installed and maintained at the USDA Forest Service Laboratory in Morgantown, West Virginia. This Dimilin database can be searched by using a bibliography program which has been created for the Forest Service. This Dimilin Bibliography program can be used like a "library" and is available for use to anyone who needs information on articles written about Dimilin. It should be noted that no human toxicology references are listed within the bibliography. Attached is a portion of the citations that have been entered into the program.

The Dimilin Bibliography program will allow you to search for specific articles. Here is a brief explanation of the different options that can be chosen within the program.

Searching the Database

The Dimilin Bibliography has several different fields:

Name of field	Type of Field
Author	Characters (240)
Year	Characters (4)
Title	Characters (240)
Source	Characters (240)
ISSN (National Cataloging System)	Characters (25)
NAL (National Agricultural Library)	Characters (25)
Language	Characters (80)
Abstract	Long

A file search may be accessed several ways.

(1) The value to be searched into the desired field will return the articles that contain the value. Examples: Search field "keyword" for %anni%. This would find records with keywords that contained Tannins, tannin, or mannitol. Search field "title" for 198_. This would match records with the years 1980-1989 in the title.

(2) To narrow the search, more than one field may be used. Example: Search field "year" 1986 and field "title" %anni%. This would find records for years 1986 with tannin in the title.

You may search more that one word in any field and you may enter as many fields as you wish.

The records within the database may be printed in two different forms. It can be printed as a bibliography citation (as for use in preparing a paper), and will not include the abstract, or printed including the abstract.

If you have any questions or would be interested in obtaining records from the Dimilin Bibliography program, please contact:

Amy H. Onken
USDA Forest Service
180 Canfield St.
Morgantown, WV 26505
(304)-285-1565
DG Address: S24L08A

National Steering Committee for Aerial Application of Pesticides - Gypsy Moth and Other Eastern Defoliators

Summary of AIPM Activities - 1991

The Appalachian Integrated Pest Management (AIPM) Gypsy Moth Program supported numerous methods improvement and pilot/special projects in FY91. These activities were conducted cooperatively with USDA-Forest Service, Agricultural Research Service, and Animal and Plant Health Inspection Service; WV/VA Departments of Agriculture; Northeast Forest Aerial Application Technology Working Group (NEFAAT); and various universities.

Several of the priorities identified by the members of the Gypsy Moth and Other Eastern Defoliators Committee at the annual meeting in Salt Lake city, UT in 1990 were addressed:

Laboratory and/or Investigations

1 - Literature data bases on non-target effects (not including human health) and efficacy for Diflubenzuron and *Bacillus thuringiensis* are computerized, accessible by cooperators, and maintained by AIPM in Morgantown. ONGOING

2 - Funding ($30,000.) provided to Dave Miller (U of CT) via cooperative agreement 42-579 to gather micrometerological data during a simulated suppression project and to continue FSCBG sensitivity analysis. ONGOING

3 - Meeting held in Maine with representatives from NEFAAT (Mierzejewski), FIDR (Dubois), AIPM (Reardon), Forest Protection Limited (Irving), Forestry Canada (Sterner), and Research Productivity Council (Riley) to discuss the need for more cooperative efforts between U.S. and Canada. An immediate priority was to conduct wind tunnel tests for selected undiluted formulations of Bt presently being used during spruce budworm and gypsy moth programs.

- evaluation of existing wind tunnel data sets (Reardon)
- develop standards (protocols) for conducting wind tunnel tests (Picot, Riley, Reardon) ASTM standards.
- conduct needed (new and redo) wind tunnel tests (Picot, Riley)
- prepare final report (Riley, Reardon) ONGOING

4 - The Forest Service (FIDR/AIPM/FPM), FPMI, and NOVO Labs to develop ready-to-use formulation(s) for Gypchek and TM-Biocontrol. ONGOING

Field Tests

1 - Conducted cooperative project with FPMI (Sundaram) and FIDR (Dubois) to evaluate techniques for quantifying Bt dosages ~~on field~~ collected foliage. COMPLETE

2 - Conducted cooperative project with FPMI (Cunningham) and FIDR (Podgwaite) with study plots in U.S. and Canada to evaluate the efficacy of the Forest Service and FPMI "standard formulations" of gypsy moth nucleopolyhedrosis virus. COMPLETE

3 - Conducted cooperative project with FIDR (Dubois), NEFAAT (Mierzejewski), APHIS (McLane) to extend Bt application timing to include 3rd and 4th stage gypsy moth larvae. COMPLETE

4 - Conducted cooperative project with U of CT (Miller), NEFAAT (Yendol/ Mierzejewski/Pendergast), APHIS (McLane/Roland) to determine spray accountability for an aerial application of Dimilin to a broadleaved forest. ONGOING

Equipment, Models and Technology Development

1 - Conduct airport trials to verify DC-3 swath widths as compared to those predicted in 1990 FPM Report Swath Width Evaluation. Week of September 23 at K&K Aircraft in Bridgewater, VA. ONGOING

Pilot Projects

1 - Continue cooperative studies with FIDR (Peacock), WVU (Sample/Butler), and VA-AIPM County Coordinators (Talley/Williams) to determine potential non-target effects of Bt on aquatic macroinvertebrates, canopy arthropods and food of endangered Virginia Big-eared Bat; and Dimilin on terrestrial/aquatic salamanders, canopy arthropods, aquatic macroinvertebrates, and soil microflora and arthropods in closed broadleaved watersheds. ONGOING

Administrative

1 - Gypsy Moth Mating Disruption Working Group formed with members from USDA Forest Service-FPM, APHIS, ARS, EPA, WV and VA State Departments of Agriculture, Hercon Environmental and AgriSense. ONGOING

2 - Participating agreement with FPMI CANADA to conduct studies involving the aerial application and quantification of microbials for control of gypsy moth populations. Also, cooperative projects planned with FPL, SERGE, RPC. ONGOING Gypchek

FY92 NEEDS:

1 - Evaluate newly developed "ready-to-use" formulations of Gypchek in terms of physical properties, wind tunnel characterization, and spray tower and field efficacy.

2 - Develop a more operational formulation for the racemic disparlure impregnated AgriSense beads.

FY92 NEEDS: cont.

3 - Adapt the Hercon pheromone flake dispenser for use on larger aircraft (e.g. Twin Beech, DC-3).

4 - Conduct the drift component of the Dimilin accountability project.

5 - Continue FSCBG model sensitivity analysis for eastern broadleaved forests.

6 - Gypsy Moth Sterile Insect Advisory Committee being formed with representatives from USDA Forest Service - FPM and FIDR, ARS, APHIS, EPA, and VA and NC Departments of Agriculture.

7 - Develop: (1) phenology model to accurately predict gypsy moth egg hatch, and (2) technique(s) to accurately estimate low density populations (less than 50 egg masses per acre) of the gypsy moth.

8 - Continue evaluation and development of techniques to quantify Bt deposit on foliage (FPMI - Sundaram, FIDR - Dubois, FPL - Irving, NEFAAT - Mierzejewski).

9 - Summarize all characterization trial data sets which involved a SWATH KIT and develop standard protocols for the characterization of aircraft.

Need to involve Canadian & west -

[illegible]

[illegible]

[illegible]

Continue evaluation and use in [illegible]
[illegible] (NMFS [illegible])
[illegible]

[illegible]

Dick Reardon

NA
Morgantown

United States Department of Agriculture | Forest Service

Reply to: 1350

Date: June 28, 1991

Subject: Gypchek Product Coordinator Activities

To: Allan Bullard
Gerry Hertel
Ken Knauer
Harvey Toko

Since being nominated as Gypchek Product Coordinator in November 1990, I've made some progress in coordinating activities among individuals/organizations involved in the development of Gypchek for operational use:

1. Coordinated with Jack Barry (Pesticide Specialist - WO-FPM), Jim Hadfield (TM - Biocontrol Product Coordinator), and Wes Yates (Ag Engineering Dept - Univ. of CA) in conducting a series of wind tunnel and spray deposit trial in Davis, CA to determine spray deposit spectra and physical properties of various tank mixes of Gypchek and TM-Biocontrol. Deposit data was also collected on Kromekote cards during field trials using various types of nozzles/atomizers in an effort to compare VMD's and droplet density for the various configurations.

2. Developed a Participating Agreement with Forestry Canada (NA, S&PF 42-623) to ensure cooperation between the USDA and FORESTRY CANADA in the field testing and development of gypsy moth nucleopolyhedrosis virus. In 1991, the Agreement covered a cooperative field test to compare the efficacy of the current Forest Service and Canadian tank mixes of Gypchek. The field test was conducted in cooperation with Dr. John Cunningham (FPMI - Sault Ste. Marie).

3. Cooperated with Podgwaite (FIDR-Hamden) to conduct field evaluations of the current Forest Service standard (2 appl, 3 days apart, 2 gal/acre) and modified (1 appl, 2 gal/acre, double dose) formulations and the FPMI formulation of Gypchek in the State of Virginia. Parts of this evaluation were replicated in Canada.

My immediate plans between now and the beginning of FY92 include:

1. Meet with Jim Hadfield to plan our cooperative activities for FY92. For example, to develop a TM-Biocontrol and Gypchek data base of laboratory and field evaluations involving various tank mixes, formulations, and aerial application technology.

2. Conduct another cooperative field trial with FPMI in Canada to evaluate new tank mixes of Gypchek and aerial application technology (e.g. AU-4000 atomizers).

3. Form a Gypchek Working Group composed of representatives from ARS, APHIS, FPMI, FIDR and FHP to organize, coordinate and transfer technology concerning the use of Gypchek.

4. Continue coordination with Karl Mierzejewski (Chairman of NEFAAT) to improve on-target deposit of Gypchek using newly developed rotary atomizers.

5. Coordinate with Podgwaite, Hadfield, and Cunningham to develop a contract by September 1, 1991 requesting the development of a ready-to-use formulation(s) for Gypchek and TM-Biocontrol.

Richard /lfc

RICHARD C. REARDON
AIPM Project Leader

cc: J. Podgwaite
M. McManus
J. Hadfield
J. Barry
J. Cunningham

RCR/lfc

[illegible]

Key Points [illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible] data.

[illegible] dealing [illegible] this situation.

[illegible]

Harry Yates
September 1991

NORTH AMERICAN FORESTRY COMMISSION
Insect and Disease Study Group
August 13-16, 1991

ISSUE PAPER

Topic: Canadian Policy On Erdaqication Of Isolated Gypsy Moth Infestations.

Issue: Canada's Policy Of Not Erdaicating Isolated Gypsy Moth Infestations In A Province After A Portion Of The Province Is Generally Infested Increases Risk of Early Infestation Of Western U.S.

Key Points:

- o Canadian Government and/or Provincial policy results in cessation of programs to eradicate isolated gyspy moth infestations once any portion of a province becomes generally infested.
- o United States policy is to eradicate all isolated gypsy moth infestations that are remote from the generally infested area. Eradication programs are carried out even if a part of an individual State is generally infested.
- o This difference in policy could result in western Canada becoming infested before the western U.S. is infested.
- o The Province of Ontario is contiguous with New York State in the east and Minnesota in the west. Eastern Ontario is generally infested with gypsy moths, but isolated infestations are present all the way to the Manitoba border.
- o No eradication programs are being carried out against isolated gypsy moth infestations in western Onatrio.
- o Uncontrolled, the isolated infestations in western Ontario could lead to an early infestation of western Onatrio. The infestations in western Onatrio could threaten to infest the western U.S. at an early date.
- o A North American strategy for dealing with this situation may be needed.

[illegible]

[illegible] such populations contain [illegible]

[illegible] (including introduced populations [illegible]

[illegible] the West)

[illegible]

COLORADO STATE FOREST SERVICE

DAVE LEATHERMAN

GYPSY MOTH RESEARCH NEEDS

1. What are the elevational limits to gypsy moth development? Perhaps these need to be defined in terms of temperature extremes, degree-days available for development, fall humidity levels which result in egg dessication, and so on.

2. What native and ornamental hosts are resistant to gypsy moth feeding, intermediate in preference, favored in the Rocky Mountain region?

3. What is the performance of the standard survey bait currently in use under arid western conditions? When is the earliest that traps could be deployed, given the fact gypsy moth males have flown as late as early September in Fort Collins?

4. Continue application of the Fl sterile technique under western conditions.

5. What native, natural enemies (either known or potential) exist in the Rockies and what influence do they have on introduced gypsy moth populations? I would include birds in this study.

6. What is (or will be) the impact of introduced gypsy moth populations on riparian ecosystems in the West?

7. If allowed to establish itself in the West, which native insects would the gypsy moth displace, which niches would it occupy?

8. Which native western lepidopterans and other non-target insects are threatened by gypsy moth control sprayings with BT, carbaryl, dimilin, etc. in both native and urban forests of the West?

9. Do western gypsy moth populations contain baculoviruses? What is the prognosis for these influencing introduced populations? What is the prognosis for using these in control projects in the West?

Oregon

DEPARTMENT O

AGRICULTURE

September 6, 1991

TO: Steve Munson, USFS-FPM, Utah

FROM: Alan Mudge, Entomologist
Dan Hilburn, Entomologist Daniel J. Hilburn
Kathleen Johnson, Plant Pest and Disease Programs Supervisor K J Johnson

SUBJECT: Gypsy Moth Research Needs

Thank you for your inquiry as to Oregon Department of Agriculture's view on gypsy moth research priorities. We feel that research on the Asian gypsy moth should receive the highest priority. Research questions that we feel should be answered as soon as possible include the following (some research may have already been initiated or completed):

1) Test traps/pheromone for efficacy for the Asian gypsy moth (AGM). Relationship between trap catches of males and presence of females?

2) Develop ability to distinguish males of AGM (if not already evident morphologically) from the European strain of gypsy moth found in the northeast United States.

3) Develop method to protect ships visiting areas infested with AGM from deposition of egg masses (e.g., lowering of AGM populations in immediate area of ports, modifying lights on ships to avoid attracting the female AGMs, modifying scheduling of ships).

4) Evaluate need for modification of eradication procedures. B.t. applications to control European GM larvae in the spring following detection of an isolated infestation the previous year is widely used in the West. Female AGM adults developing from larvae ballooning from infested ships could substantially disperse the population during the first year of arrival prior to the traditional time for eradicative sprays. Might an application within a couple of weeks of infestation be warranted to areas known to have received ballooning larvae from infested ships?

5) Evaluate methods to adequately identify, inspect, and clean-up at-risk ships for AGM.

6) Develop additional basic information on biology, ecology, behavior, and control (e.g., B.t) of AGM in Siberia, on ships, and expected in the United States. Data on eclosion/developmental times and temperature are of particular concern in order to determine which times of year AGM can be successfully established outside Siberia (especially in , but not limited to the United States). Experiments which vary temperature levels to mimic scenarios in which egg masses would be moved to various ports of call would be also useful.

(see page two)

BARBARA ROBERTS
Governor

635 Capitol Street NE
Salem, OR 97310-0110

Some priorities on research on the gypsy moth from the northeastern United States (GM) are as follows.

1) APHIS Survey Plan: establish realistic protocols (i.e. detection trap density) supported by the survey plan to detect isolated infestations before they reach an upper size limit. Current plan is inadequate as written. Particularly rural areas in the West.

2) Develop information on larval (first instar) and adult GM dispersal in isolated infestations, in order to make eradicative spray blocks as small as possible. For example, create "artificial" isolated infestations using sterile F_1 larvae (later than first instar to avoid dispersal by larvae) and monitor subsequent male dispersal. This could also be done using first instar larvae to see if there is any significant difference between larval/adult dispersal versus adult dispersal. "Infestations" of various sizes could also be created and results monitored. In order to accomplish this, a method to differentiate sterile from fertile male adults would be necessary.

3) Operational status of F1 releases for isolated infestations?

Additional ideas:

4) Review natural spread and vegetation patterns. Make long-term probability predictions on natural spread (When can we expect GM to reach Oregon through natural spread? By what route?)

5) Develop method of linking trapped males with egg masses/pupal cases they might have hatched/emerged from.

September 1991

STATE OF UTAH
DEPARTMENT OF AGRICULTURE
MARK QUILTER

SUGGESTIONS FOR GYPSY MOTH STUDIES IN THE INTERMOUNTAIN AREA

The following are recommendations for studies to be conducted on Gypsy Moth in the Intermountain states.

1. The most critical problem for Intermountain states is the early detection of the insect. The trapping schemes used in the East do not apply very well in the mountainous terrain. Trapping methods need to be developed for canyon areas that have drainage winds, areas of low humidity, and many differing microclimates in a small area. Where the Intermountain area has determined that eradication is the only possible alternative in dealing with GM, then strong detection and population delimiting methods need to be developed. Perhaps release studies of male moths could be conducted to determine best method of trapping. With the small isolated populations that arise in the area, it would probably be better to simulate infestations so that plans can be developed that have confidence before actual infestation occurs.

2. Methods need to be developed for population delimiting. How far can young larva balloon in the canyon areas? How far out should delimiting traps go from a catch?

3. Are there methods for egg mass or female detection? Even though costly, perhaps they may be more cost effective in this area.

September 1991

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

JOHN CONNELL

SUGGESTED RESEARCH TOPICS FOR GYPSY MOTH

1. Improved trap design to identify low level populations.

2. Environmentally sound delivery system for disparlure mating disruption. Elimination of unwanted plastic wafers since they represent a source of pollution.

3. Contact properties of dimilin. Is the product effective as treatment on trunks and scaffold limb against migrating larvae? This would allow treatment by ground of trees near water.

4. What is the specificity of disparlure? What other pest species may be attracted that are not being targeted by trappers?

5. Research to improve the consistency of NPV's results in the field.

THE USE OF GLOBAL POSITIONING TO PLACE AND RETRIEVE GYPSY MOTH TRAPS IN THE WASATCH RANGE OF UTAH

by

Matt Hansen and Al Dymerski

Utah's gypsy moth trapping program includes placement and retrieval of delimiting traps placed on a 2000 foot grid in the Wasatch Mountains. The terrain is generally steep with slopes ranging from 60 to over 100 percent. Vegetation is mostly oak brush with pockets of conifers on north aspects. Many traps are placed away from roads, trails ,and other easily identifiable landmarks. The difficulties associated with navigating under these conditions and poor trap retrieval success during the 1989 season initiated use of Global Positioning System (GPS) Trimble Transpak units. At the time of purchase (spring 1990) Trimble Transpaks offered the best combination of affordability, durability and ease of operation for existing field conditions.

In 1990, 220 traps were placed using 7.5 minute quad map locations with 1:12000 color aerial photography. Crews then recorded a GPS fix (latitude and longitude) at the site if adequate satelites were available. Successful reception of satellite signals was displayed digitally on the unit as either "2D" or "3D" readings. For instance, a "2D" position fix requires a 3 satellite array and the "3D" position fix, considered to be optimum for reception of satellite signals, indicates the unit is receiving signals from 4 satellites.

During trap retrieval, the Transpak navigation mode was used to obtain direction and distance measurements. This process was used by field crews in lieu of maps, photographs and flagging to retreive previously placed traps where position fixes had been recorded. Table 1 lists the distance from the Transpak selected site to the actual location of the gypsy moth trap. In over 41 percent of the retrieval efforts, no fixes were available due to insufficient satellite coverage on the day of trap retrieval.

Table 1. Distance to Original Fix From the Trap Retrieval Fix Coordinates in Meters.

	No Retrieval Fix	<50m.	51-100m.	101-200m.	>200m.
# Trap Sites	91	38	32	26	33
Percent of Total	41	17	15	12	15

Errors in excess of 100 meters are considered to be too great to be of value in trap retrieval. The Transpak was nearly as likely to be over 200m off as it was to be within 50m. The distance between placement and retrieval can be attributed to a large extent on an incomplete satellite constellation that results in a variation in fixes between trap placement and retrieval. Other factors that influence position fixes include local topography and vegetative cover. For example, steep narrow canyon bottoms would rarely recieve satellite coverage resulting in even a "2D" fix.

Improved operator training and pre-mission planning will result in improved accuracy. Additionally, a full complement of satellites and correcting problems associated with terrain and vegetative cover will improve GPS performance. Field testing of the GPS Trimble Transpak is continuing during the 1991 Utah gypsy moth trapping program.

SHASTA-TRINITY NATIONAL FORESTS

SHERI SMITH

GYPSY MOTH MODEL PROJECT UPDATE 1991

The gypsy moth (GM), Lymantria dispar (L) (Lepidoptera: Lymantriidae, has been trapped in Utah throughout a wide range of habitat conditions and elevations. This distribution of life stages over various climatic temperature gradients provides an opportunity to test phenology models that have been developed for GM populations in other areas of the U.S. Accurate phenology predictions that account for temperature differences within the geographic area would enable pest managers in Utah to schedule specific treatment areas for application during the time when maximum effectiveness against specific life stages would be expected to occur.

Prediction of GM development in Utah using phenology models was initiated during 1990. Temperature recording datapods (Omnidata, Logan, UT) were installed at nine locations (Table 1). Daily maximum and minimum temperatures recorded by the datapods were used to predict egg hatch using GMPHEN (Gypsy Moth Phenology Model, Katharine Sheehan). Egg masses were obtained from Otis Methods Development Center, Mass. and placed near the datapods on 3 December 1990. These egg masses were monitored for initial egg hatch.

This report summarizes the findings for four of the nine locations. The weather files containing daily maximum and minimum temperatures (C^{o}) begin on January 1 (Julian Day 1) and end on June 19 (Julian Day 170), therefore, the "part of one year" option was selected in GMPHEN. The default degree day calculation method and the default developmental parameters were used to predict initial egg hatch date. Actual egg hatch date from the emergence cages occurred later (9-27 days) at each location than that predicted by GMPHEN (Table 2). The differences between the predicted and actual egg hatch dates may be due in part to the caged egg masses not coming from local populations and/or different development parameters required by local populations.

The GMPHEN model, using the default parameters, does not predict egg hatch accurately enough at this time to use it as a tool to assist pest managers in timing spray applications. It is hoped that with the current information and that obtained from the remaining five locations GMPHEN can be adapted to fit Utah populations.

Table 1. Location and elevation of the 9 datapods and caged egg masses in Utah

LOCATION	ELEVATION (feet)
Provo Canyon	5,120
Provo Canyon	7,280
Little Cottonwood Canyon	6,120
Olympus Cove	5,080
Millcreek Canyon	6,040
Big Cottonwood Canyon	5,240
Little Mountain Summit	6,240
Bountiful City	4,520
Mueller Park	5,420

Table 2. Actual and predicted egg hatch dates for 4 locations in Utah.

LOCATION	EGG HATCH DATE	
	ACTUAL	PREDICTED
Provo Canyon	April 30, 1991	April 22, 1991
Olympus Cove	May 9, 1991	April 14, 1991
Big Cottonwood Canyon	May 8, 1991	April 17, 1991
Bountiful City	April 30, 1991	April 20, 1991